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THE IMPACT OF LOCAL GOVERNMENT ON

INTRA-METROPOLITAN LOCATION

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Number 45 March 1971

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I. Overview of the Model

The model to be presented in this paper treats both the location decisions of economic agents and the tax and expenditure decisions of local governments as mutually influencing endogenous processes. Thus, in an important sense we shall be dealing with a closed system. This characteristic is a significant inclination toward realism. Other aspects of the model, unfortunately, will lean otherwise because of the need to achieve notable simplification to make the model tractable at this stage, since the relationships which are included produce a difficult complex. The model is advanced as one of a set of studies which attempts to come to grips with progressively more intricate representations of the political-economic interplay within an American-type metropolitan area -- a metropolitan area with fragmented local governmental jurisdictions as components of a federal system. These studies consist of both theoretical and econometric manipulations in order to gain appreciation of the issues and magnitudes involved. The present paper contains only a theoretical examination, and the model is presented in an informal, largely graphical fashion to facilitate an intuitive grasp of the materials.[1]

We begin by assuming that there are two local governmental jurisdictions -- a central city and a suburb. We next assume that the population of the area is fixed for the period under study.[2] This population is homogeneous with respect to the demographic factors which are usually held to influence household location choice between

city and suburb,[3] but is assumed to differ in income level. The income distribution approximates what actually prevails in such areas.

The population is faced with the choice of whether to reside in the central city or the suburb. Business firms -- both industrial and commercial -- are also deemed to have to make this decision, but the present model simplifies their choice substantially to highlight the residential location decision. Business choices are treated as essentially exogenous. Subsequent models attempt to treat both residential and business location as endogenous.

Suburban location differs from central city location in three respects: (1) it has less dense land use, (2) it is generally less accessible, (3) it is governed locally by a separate jurisdiction than that of the central city. The first two differences are related: they both stem from our assumption that business, cultural and recreational destinations are disproportionately concentrated in the central city within the relevant range of spatial distributions dealt with in this paper.

There are accordingly four general concerns which influence residential location decisions: (1) the basic substitutability of city and suburban land (such that price differences greater or less than the value of the use differences between them will exert systematic tendencies for shifting from one to the other); (2) preferences for greater or lesser density land use; (3) the configuration of relative accessibilities defined in terms of particular employment, shopping, recreation, etc. destinations; and (4) advantages and disadvantages of being governed by the city versus the suburban jurisdiction. The model organizes these concerns so as to illuminate and weigh the positive and negative forces for choosing one over the other. Suburban location will

will be favored by strong preferences for low land density (which we call "privacy"); by a particular minority combination of employment circumstance and commodity preferences which make suburban destinations more relevant than central city destinations (so that it is central city location that is the less accessible); by financial and commodity preference advantages inhering in being governed by suburban rather than central city government; and by relative prices between the two locations such that net central city advantages are overpriced of suburban advantages underpriced.

An earlier model of the same type being presented here developed in detail a number of specific advantages for suburban location.[4] They fall under two general heads, land use density and jurisdicitonal separateness.

1. Land use density: the advantage and cost of "privacy". Low land use density affords a kind of "privacy" of living space -- both within the home and in public. It is a commodity, subject to purchase, and at a price. We considered it a luxury good, with income elasticity greater than 1. Its price is the accessibility generally sacrificed[5] to attain it. This price can be expressed as that part of the cost of lesser accessibility which is not offset by a land price differential between suburb and city. Its magnitude thus depends on travel costs (including the value of time), and land price differences. The overall advantage relates the value of the degree of privacy available to potential recipients -- which degree is itself a variable, depending on the difference in land use density between city and suburb -- to its price. Both valuations are specific to the circumstances of the households

involved. In general, higher income households will find net advantages greater than will lower income households.

This tendency is augmented by a suburban governmental device -- minimum lot zoning. Such zoning legally prevents the erosion of low density use by setting effective ceilings on total residential use. It operates by imposing additional housing costs on households that would, in the absence of the zoning constraint, have bought a smaller land component than officially required in their housing service complex. This cost affects lower and moderate income families, but not richer ones.

2. <u>Jurisdictional separateness: advantages of fragmented "home rule."</u> There are advantages to be obtained by placing oneself -- through establishing residence -- under the jurisdiction of a suburban government rather than a central city government. Three important types concern (a) inter-jurisdictional spillover effects, (b) the differences in jurisdictional income and the cost of public services, and (c) the burden of welfare payments.

a. Interjurisdictional spillover effects. Because of the elaborate set of interrelationships in a metropolitan area, city residents have a presence in the suburb and suburbanites have a presence in the city. They make use of one another's private and public services. Because of the basic asymmetry between city and suburb regarding concentration of business, government, and recreation, however, there is greater suburban presence in the city than the reverse. While cross-use of private goods is completely recompensed by private exchange transactions, such cross-use of public goods is inadequately paid for because of the lack of subtle enough means of calculating liabilities, the unavailability

of adequately pinpointed tax mechanisms, and the inability generally to exclude outsiders from the benefits. In providing for quality-quantity levels of public output desired by their own residents, governments find themselves having to incur costs in excess of what would be necessary if outsiders were not able to have a "presence" across jurisdictional lines. The asymmetry of such presence between city and suburb means that the total tax liability on city residents is inflated by a charge for that part of suburbanite-generated public service costs which could not be collected from suburbanites. The city resident's tax rate will exceed that of the suburbanite even where both city and suburb offer the same level of public services to their residents. These interjurisdictional spillovers or external diseconomies give a financial advantage to locating in the suburb. Here too, the amount of the advantage is a rising function of household income level. Of course, no such discrepancy would appear if suburbanites, despite this very same "presence" in the central city, were constituents of a single metropolitan-wide jurisdiction, for then internal taxation could raise the appropriate compensation and impose the appropriate incentives on economic agents. It is jurisdictional separateness that permits the problem and thus the artificial advantages to suburban location to arise.

b. Income level and price differences. In any jurisdiction with a tax which is a positive function of household income, households having incomes higher than the mean will pay more than those at and below the mean. Moreover, if a group of those above the mean seceded to form a new income-homogeneous jurisdiction with populations equal in the two jurisdictions, the same total public expense in the two would elicit a

lower tax rate in the richer community than in the poorer. Thus, any household would, in moving from the poorer to the richer community, experience a virtual decrease in the cost of public services; but, once again, this decrease is greater in absolute amount the higher is the household's income level. This tax rate differential is an advantage like being faced with a decrease in the price of a private good consumed by the household. The value of the benefit is measured by the consumer surplus gain resulting, and this depends partly on the response to lower price forthcoming in the amount of the good consumed.

Public good consumption does not respond to the choices of any one household, but it does respond to the choices of the whole resident population. This is the respect in which public choice is endogenous in the system. We assume that public choice can be predicted as the majority vote of the electorate. In making the predictions, we must know the preferences of each member of the electorate, and how these change, so that a pattern of majority vote can be inferred from each set of circumstances.

A short-cut predictive device can be used in certain circumstances — namely, where preferences of the whole electorate can be represented in terms of distances along a single dimension ("single-peakedness"). In the present model, where public services are homogeneous ("quality" differences are really differences in a quantity level per capita), this is not a bad approximation. Under these circumstances we can predict majority vote as the value of the median preference position. In the further specialization of the present model, involving a nearly symmetrical income distribution, similar tastes, a proportional income tax, and relatively constant price and income elasticities for public goods in the neighborhood

of mean income, the median income household has the median preference position.[6] So public good demand in the richer community exceeds that of the poorer. A given household, in moving from poorer to richer community, experiences both a lower price and a larger public demand. This reflects the higher community income level, and the lower price which the higher income of the community makes possible. The households, in moving, shares the benefits of the community's higher income through the collective redistribution resulting from a single tax rate in the jurisdiction. So the higher level of public good provision, along with the lower price, enter as the measurement of benefit. They are the fruit of a richer-than-average portion of the overall SMSA population being able to segregate itself as a separate jurisdiction so as to begin and remain relatively uncontaminated by the presence of lower income households whose circumstances would produce a less satisfactory and more expensive public good output for the wealthy.

Here too it is the richer households that obtain the benefit, and the richer the household the greater the benefit, but at the expense of the poorer households.

c. The burden of welfare payments. We can distinguish between the level (quality or quantity) of provision of government services and their distribution among the population. The provision of certain "welfare-type services" is treated in the present model not as a separate type of public good but as a characteristic of the distribution of homogeneous public goods. "Welfare clients" are those who consume considerably more than the average amount of public goods. We assume, for example, that a fixed supplemental "welfare package" of public

services goes to welfare clients over and above the normal (variable) complement of public services provided generally, and that the norms within the metropolitan area are homogeneous enough so that this supplement is the same both in the central city and the suburb. Then if a given amount, or constant per capita expenditure, of resources is to be used to furnish public services in a jurisdiction, the greater is the proportion of welfare clients in the jurisdiction's population, the lower is the general level of provision that can be made with these resources. In effect, therefore the welfare client load affects the real price of furnishing any general level of public goods. This influences the well-being of all members of the population in the same direction -- including the welfare clients themselves, since each such client consumes higher absolute levels of public goods (normal plus welfare package) the fewer other welfare clients there are in a given total jurisdictional population.

Thus, two communities with different percentages of "welfare households" will face different real prices for public goods -- i.e., a different average tax rate per unit of average consumption of public goods. As in the second category, higher income households will thus experience higher total benefits than lower income households. Insofar as suburbs have substantially lower percentages of their populations in the welfare case load than central cities, the price of public goods will tend to be less there than in the latter on this account, thereby augmenting similar differences for the other two types of advantage. This constitutes an additional inducement to move from central city to suburb, an inducement that is stronger for higher than for lower income households.

The key to both the last two types of advantage rests in suburban residence being attractive to[7] above average income groups and unattractive to significantly below average groups. The separate jurisdictionality of the suburb makes this possible, especially through the public policy of minimum lot zoning. This exacerbates the regressivity of suburban attractions: not only are these attractions less strong for the poor than the rich, they are actually negative. The poor are repelled by a prospect of net loss from suburban location. So income selectivity is maintained and, with it, the original sources of attraction.

The fundamental thesis of the model is that every household that can gain by moving from central city to suburb will do so. An equilibrium exists when everyone who can gain from such a move has done so, and the marginal household refraining from the move just fails to be able to profit from the move. The reason why any household should fail to gain is that the size of all of the types of advantage noted is a rising function of income and falling function of number of movers. Since richest gain most, they move first. Subsequent moves are by less rich. Thus, the larger the number of movers the lower the income level of the marginal mover. In addition, as noted above, the gains from land density are actually negative for lower income families. First, privacy is much diminished as the suburban population rises and in any case is not a highly valued commodity for such families. Moreover, travel costs to overcome inaccessibility are significant for such families and suburban land costs rise with larger population. Finally, minimum lot zoning requirements represent a greater and greater cost the

lower is family income, since the discrepancy between desired and minimum required lot size widens as income declines. Thus, net advantages are negative for some families, positive for others, and at the margin, zero. The marginal mover experiences zero or slightly positive gains, the marginal non-mover zero or slightly negative gains.

The boundary between movers and non-movers is not fixed. It is influenced by a number of environmental characteristics, some of which are subject to policy manipulation by the respective jurisdiction governments. The central city government can influence location decisions by varying the amount of taxes collected from suburbanites to offset externality-generated resource costs. They can also vary the percentage of resident-derived revenues which they levy on land as opposed to improvements. Since the supply of land is inelastic while that of improvements is not, taxes levied on the former have little discouraging effect on location,[8] while the latter, since they can be avoided by locating outside the jurisdiction, tend to discourage city location.

The suburban government possesses the same choice between land and improvement tax. In addition, it employs two zoning instruments which have further influence on location. One stipulates minimum lot sizes for residential use, the other stipulates the maximum amount of business acreage that may be permitted. Since in the present model we assume the size of the suburb to be fixed, the first of these in effect sets an upper limit to the suburban resident population. The second directly sets a similar ceiling on business activity. The present model concentrates on residential location. But business

location is not omitted. The distribution of businesses is assumed to be an important influence on residential location decisions. It is handled here largely as an exogenous variable. Businesses are assumed to have been excluded by the suburbs through zoning against their will. They locate there to the full extent permitted by the zoning ceiling. If the zoning ceiling is lowered or raised, business changes to the exact level of the new ceiling. Thus, suburban government can directly influence the distribution of business within the metropolitan area by manipulating its business zoning. We assume that while they may make variations in it, however, they do not extend the ceiling so far as to wipe out the essential disparity of business concentration between city and suburb -- and therefore the essential character of the two.

The two governments are assumed to act as agents of their constituents in employing these policy instruments. As an approximation, their interests are assumed to be advanced by attempting to maximize the productivity of their jurisdiction as a site for economic activity. This implies that each government acts to maximize the total value of land in its own jurisdiction.

The maximization process therefore works as follows. Say that a set of values has been set by the two jurisdictions for its policy variables, all but one at its optimal level. With this initial set, a given configuration of potential gains from suburbanization emerges. Prospective gainers move, thereby determining an equilibrium value of suburban population size. This determines a split in the population array in terms of household income level: marginal migration income is determined.[9] The partition of the income array determines the mean

and median income levels in each jurisdiction. The size and nature of the gains from jurisdictional separateness, together with the income level differences, determine the virtual price levels of public goods facing constituents in each jurisdiction (a different real price for each household income level). These price levels, together with the array of household incomes, determine the majority vote level of public output to be provided. Thus, public finance and other policy instruments, through their effects upon location decisions, induce indirect reverberations upon public expenditure decisions. The public sector is both an initiator and recipient of decision-making impulses.

Now, suboptimality is recognized in the policy decision of one jurisdiction: a change in the one misaligned policy instrument would raise total land value. So the government changes the value of the sole misaligned instrument. This changes the pattern of prospective gains from suburban over city location, so households now dislodged from equilibrium make their equilibrating location adjustment. The result is a new optimal suburban size and hence a new partitioning of the income array. This leads to a different set of public output prices confronting constituents of each jurisdiction. Finally, a new set of equilibrium relative public output levels results.[10]

This is a brief overview of the character of the model. Hereafter we shall be concerned to spell out more precisely the nature of the various adjustments carried out, the properties of the equilibrating process and of the equilibrium configuration, and the consequences of a system with relationships such as the ones postulated here. Our central focus throughout is the impact which the character of local government has on the jurisdictional (and hence spatial) distribution of

of economic activities, and the reciprocal impact which this latter in turn has on the former.

A more precise specification of the model follows.

II. Specification of the Model

First, we assume that the production of public services is perfectly responsive to the community demand. This demand is expressed as the outcome of an exhaustive series of paired comparison votes, each decided by majority rule. The alternatives of choice are different quality (= quantity per capita) levels of public service output (where outputs are expressed in homogeneous service units, and are distinct from inputs used in the public sector). We assume that individual preferences over these alternatives are uni-dimensional ("single-peaked"). So the outcome of majority rule voting will be the median most preferred alternative within the population. With certain regularity assumptions on preferences and income distribution we approximate this as the preference peak for the median income level recipient (since preferences vary in this model only according to income differences). Thus, the jurisdictional demand for, and hence supply of, public services is given in (1):

(1 a-b) $\quad G_i = G\ [\tilde{y}_i(N_i),\ \tilde{\tau}_i\ ] \quad i = 1,\ 2$

where $\quad G_i$ is the level of per capita public services in jurisdiction i (i - 1, 2 central city, suburb respectively)

$\tilde{y}_i(N_i)$ is the median income in i when the population of i is N_i

$\tilde{\tau}_i$ is the per unit (output) price of public services to the median taxpayer in i,

and where the public service price is equal to the tax rate times the relevant income tax base; so:

(1 c-d) $\quad \tilde{\tau}_i = \tilde{y}_i(N_i)\ P_i^R, \quad i = 1,\ 2$

where P_i^R is the location-relevant jurisdictional tax rate per unit of public output, to be defined below.

For econometric estimation purposes, the income distribution in the overall metropolitan population would have to be estimated. Then, in the light of the relationships in the model it would be possible to predict the ordered array of potential suburban migrants, thereby determining for each hypothetical size of the suburb (N_2) and central city (N_1) the income level identity, and so the income distribution, in each jurisdiction.

Strictly speaking, these distributions are endogenous to the model. For purposes of computer simulation, however, a short-cut approximation can be suggested. On the basis of data on actual metropolitan area (SMSA) income distributions and the monotonicity of advantages for suburban location with respect to household income level, we can express reduced form approximations of the jurisdictional income distributions directly. In doing so, it will be convenient to make use of a procedural simplification designed to throw the critical issues into relief — namely, that the SMSA population is constant over fulctuations in inter-jurisdictions migration. Thus, $N \equiv$ SMSA population = constant. Since $N_1 + N_2 = N$, this constancy means that we may deal in population proportions unambiguously. Each N_1 uniquely implies an $\frac{N_1}{N}$ ($= n_1$) and an $\frac{N_2}{N}$($= n_2$), (with $n_1 + n_2 = 1$).

We then approximate the jurisdictional medians as follows:

(2a) $\tilde{y}_1 = \gamma_1 + \gamma_2 n_1$ with $\gamma_1 + \gamma_2 = \tilde{y}$

(2b) $\tilde{y}_2 = \tilde{y} + \gamma_3 n_1^\lambda$ with $\lambda > 1$ and $\tilde{y} + \gamma_3 = y^H$

where $\tilde{y}$ is median income in the whole SMSA population.

y^H is the highest income recieved in the SMSA population.

We now turn to the cost function for public services -- the relationship between the cost of the productive inputs and the output of public services. The distinction between the two is central to the present approach, and differs from traditional treatment which measures public good output by the value of inputs used to produce them. Four aspects must be considered. First is the sheer resource cost of providing certain public commodities in different types of communities — characterized by size, population, composition, and certain relevant, non-social environmental factors. Important issues are involved here, but these are somewhat more conventional than the aspects which the present work is emphasizing. To help throw these latter into relief, we make some extremely simplifying assumptions concerning the former.

To begin, while public goods may be heterogeneous, we allow variations only in the size of packages of these goods held in fixed composition: i.e., changing levels are measured in terms of homogeneous package sizes. Moreover, we assume that although our public goods do generate important externalities, they are not "pure" public goods, in the Samuelson sense. In order to provide a constant quality of public services as population increases, additional resources must be used to offset crowding phenomena, to meet higher distribution costs, etc.[11] Our simplification here is to assume that the per capita cost of each unit of service output is constant: i.e., zero scale economies or diseconomies, both with respect to population size and quality level of public goods provision. This scale neutrality enables attention to be fixed on the other issues which this model stresses. It can, however, be relaxed without contradicting -- but masking somewhat -- the basic relationships. Finally, we assume that the constant per capita cost of

public services is unaffected by type of community.

The three other aspects concern the sources of attractiveness of suburban location. These sources are reflected in the price of public services and, as such, affect public output and location decisions. The first of these is interjurisdictional externalities. This in turn has two facets: (1) the differential presence of suburbanites in the central city (over city dwellers' presence in the suburbs) raises the resource cost of each level of per capita public services in the city relative to that in the suburb; (2) taxation of suburbanites' presence to recoup some of the externality effects itself incurs administrative and allocational costs.

The second source of suburban attractiveness is jurisdictional income level differences. This has the effect of creating jurisdictional differences in the tax rate necessary to finance any given total resource cost. It can be reflected by expressing each total resource cost as a cost per dollar of tax base.

The third source is the impact of the welfare case load. As indicated earlier, we assume that each welfare client in the SMSA receives the same welfare supplement in public goods over and above the normal per capita consumption level. As a result, a given total of resources will furnish a lower normal per capita public service level to everyone the higher is the welfare case load as a proportion of the total population. Consequently, production of each desired normal per capita level in any jurisdiciton will cost more the larger is the proportion of the population of that jurisdiction which is on welfare. Interjurisdictional cost differences on this account will therefore depend on relative proportions of the population

on welfare in the two jurisdicitons.

The four relationships discussed are shown in equations (3 a-b) and amplified in (4), (5) and (6).

$$(3a)\qquad P_2 = \frac{\Phi_2 S N_2}{\bar{y}_2 N_2} = \frac{\Phi_2 S}{\bar{y}_2}$$

$$(3b)\qquad P_1 = \frac{\Phi_1 S N_1}{\bar{y}_1 N_1} + t_E \frac{E(G_1, N_1, N_2) + C_E(1-t_E)}{G_1 \bar{y}_1 N_1}$$

$$= \frac{\Phi_1 S}{\bar{y}_1} + t_E \frac{E(G_1, N_1, N_2) + C_E(1-t_E)}{G_1 \bar{y}_1 N_1}$$

$$C_E \geq 0,\ C_E' \geq 0,\ E(G_1, N_1, N_2) \geq 0,$$

$$\frac{\partial E}{\partial n_2} > 0,\ \frac{\partial E}{\partial n_1} < 0,\ \frac{\partial E}{\partial G_1} > 0$$

$$(4)\qquad \Phi_i = \Phi\left(\frac{N_{wi}}{N_i} \div \frac{N_w}{N}\right)\ i = 1, 2 \,\Big|\, \Phi_i > 0,\ \Phi_i' > 0 \quad \begin{cases} \Phi(>1) > 1 \\ \Phi(<1) < 1 \end{cases}$$

$$(5)\qquad N_{w1} = N_w(\bar{y}_1, \sigma_{y_1}) \quad \frac{\partial N_{w1}}{\partial \bar{y}_1} < 0,\ \frac{\partial N_{w1}}{\partial \sigma_{y_1}} > 0$$

$$(6)\qquad N_{w1} + N_{w2} = N_w$$

where P_2 is the unadjusted price of public goods per unit output per dollar of tax base (income) in the suburb;

S is the constant per capita resource cost of a unit of public good provision;

$\bar{y}_2$, $\bar{y}_1$ is mean per capita income in the suburb, central city respectively;

Φ_i is a cost multiplier reflecting differential proportional welfare client population in jurisdiction i;

σ_{y_1} is the standard deviation of the income distribution in the central city.

t_E is that proportion of interjurisdictional externality cost to the city which is not recaptured by taxation of suburbanites

$E(G_1,N_1,N_2)$ is the externality cost function (it includes G_1 as argument because N_1 and N_2 establish essentially a percentage cost increase while G_1 converts this into an absolute number by providing the right scale

$C_E(1-t_E)$ is the administrative, etc. cost function for city taxation of suburbanites

N_w is the total welfare client population in the SMSA

N_{w1}, N_{w2} are the welfare client populations in jurisdictions 1, 2

P_1 is the unadjusted per unit, per dollar price of public goods in the central city

σ_{Y_1} is the standard deviation of the income distribution in the central city.

Equation (3a) indicates that P_2 depends only on the common per unit per capita resource cost, the welfare load multiplier, and these converted to a per dollar price basis by means of average per capita income in the suburb. P_1 differs from this in having larger welfare load, lower per capita income, and in being increased by the net average cost of interjurisdictional externalities. All of these tend to make $P_1 > P_2$. The second term of P_1 is the per unit per dollar sum of the uncompensated externality cost and the administration costs of taxes on suburbanites.

Equation (4) shows the welfare cost multiplier for each jurisdiction as a function of the excess welfare client load in that jurisdiction. Determination of this welfare client load is shown in equation (5), as amplified by equation (6), which assumes a constant number of welfare clients in the fixed total SMSA population. (5) shows the welfare load in the city as a function of the mean and standard deviation of

the income distribution in the city. A higher mean is associated with a lower load, a wider dispersion with a higher load.

We now turn to the residential location decision. A household will move from the city to the suburb[12] if it can realize positive net benefits from so doing. All households expecting positive net gains are assumed to move.[13] Since the gains are a descending function of household income level and, as we shall indicate below, for each set of policy parameters become negative below some income level, an equilibrium distribution of the population between city and suburb can be established. All households with positive prospective gains will suburbanize, all with negative gains will locate in the city, and the marginal household will be indifferent between the two: will have zero prospective gains. Given the monotonicity of net gains with income level, all we need do is discover that income level at which net gains are zero. This determines the equilibrium dichotomization of the population -- the equilibrium locational distribution, as expressed in the equilibrium condition below:

$$(7) \qquad \Pi_{j(N_2)} = 0$$

where $\Pi_{j(N_2)}$ is the net gain from moving from city to suburb experienced by the resident in the suburb with smallest net gains when suburban population is N_2: i.e., the net gain of marginal suburban resident $j(N_2)$ for population size N_2.

As discussed above, there are two main types of prospective gain for suburban residence: land density gains and jurisdictional benefits. Thus:

$$(8) \qquad \Pi_{j(N_2)} \equiv \Pi^D_{j(N_2)} + \Pi^J_{j(N_2)}$$

where $\Pi^D_{j(N_2)}$ are the land density benefits accruing to marginal suburbanite $j(N_2)$ for suburban population size N_2

$\Pi^J_{j(N_2)}$ are the jurisdictional benefits for $j(N_2)$.

Land density benefits result from living in an area where land density is less than in the city: the consumption of "privacy" (D). These benefits are offset by the fact that suburban location is, on balance, less accessible to desired trip destinations than city location. Travel costs (including the cost of time lost and inconvenience) must be paid. In addition, the suburban jurisdiction imposes minimum lot size zoning to preserve some differential "privacy" relative to the city. For households who would have chosen, if unconstrained by zoning, to consume a smaller than the required minimum lot size this represents an additional utility loss -- because the family's limited budget is constrained to an allocation less satisfactory than what it would have chosen, given only its own tastes and relative market prices. The net gain is therefore the resultant of these three considerations. This is expressed in equation (9):

$$(9) \qquad \Pi^D_{j(N_2)} = \Theta_{j(N_2)} Q(h) \left\{ U^{j(N_2)} \left[X^*_2(D, P_D, H^*) \;\middle|\; D(N_2, b_2), H^* \geq H^{Z_R} \right] - U^{j(N_2)}(\hat{X}_1) \right.$$

$$(9a) \qquad \bar{P_D} \equiv V_{j(N_2)}\left(b_2, Y_{j(N_2)}\right) - (r_1 - r_2)\, H^*$$

where $\Theta_{j(N_2)}$ is the inverse of the marginal utility of income of household $j(N_2)$

$Q(h)$ is the present value capitalization factor, with h the interest rate

$U^{j(N_2)}$ is the utility function of $j(N_2)$

$X_2^*(D,P_D,H^*)$ is the constrained maximum consumption package that would be chosen by household $j(N_2)$ with suburban location when the housing lot selected, H^*, must be at least equal to the legal minimum established by zoning, H^{ZR};

$D(N_2, b_2)$ is the amount of "privacy" consumed in the suburb -- a function of the size of the resident population, N_2, and the percentage of SMSA business activity that takes place in the suburb, b_2. ($B_1 + B_2 = B$ are the absolute amounts.);

P_D is the cost of inaccessibility;

$V_{j(N_2)}\left(b_2, y_{j(N_2)}\right)$ is the capitalized value to household $j(N_2)$ of annual travel costs from suburb boundary[14] to city trip destinations, and is a function of b_2 in that the number of such destinations depends on the geographic distribution of business activity (as a major determinant of desirable destinations), as well as on $y_{j(N_2)}$, since this influences the value of the time cost of travel;

r_1, r_2 are the capital values of a unit of land in city and suburb, respectively;

$\hat{X}_1$ is the optimal consumption package that would be chosen by household $j(N_2)$ in a city location, and consistent with the same taste, price and income constraints as apply to X_2^*.

In the "second best" suburban consumption package X_2^*, D and P_D are environmental variables determined outside the household. Given the

household's tastes and income, and the relative prices of all other commodities (plus D and P_D), the household selects some $H^*, H^* \geq H^{ZR}$. This dependence is shown in (10):

$$(10) \qquad H^*_{j(N_2)} = H^*\left[U^{j(N_2)}, y_{j(N_2)}, D, P_D, (P) \right]$$

where $y_{j(N_2)}$ is household $j(N_2)$ income level

(P) is the vector of prices of all other commodities

The other source of locational advantage is jurisdictional gains. This takes the form of differential tax rates and consequent differential levels of public services between jurisdictions. It results in a consumer surplus advantage to the household moving from high tax rate-low service level jurisdiction to low tax rate-high service level jurisdiction. This is measured conventionally as 1/2 the cross product of differential public good price and differential public good level. The relevant price differential is that which faces the marginal mover $j(N_2)$. As such it contains two elements: the differential jurisdictional tax rate -- which is external to household $j(N_2)$ -- and the translation of this into the absolute cost confronting the household via its own income level. The relevant public good level is wholly external to the marginal mover: it is determined by the distribution of population between city and suburb and the resulting median preference majority vote decisions.

This is shown in equation (11):

$$(11) \qquad \Pi^J_{j(N_2)} = \frac{1}{2} Q(h)\, y_{j(N_2)}\, (P^R_1 - P^R_2) \left[G\left\{\tilde{y}_2(N_2), \tilde{\tau}_2(N_2)\right\} - G\left\{\tilde{y}_1(N_1), \tilde{\tau}_1(N_1)\right\} \right]$$

where $Q(h)$ is once again the present value capitalization factor.

Equation (11) employs "location-relevant" tax rates both directly and as a determinant of public good provision (in τ_i). The concept of location relevant tax rates stems from the different locational disincentive of a tax on land and a tax on mobile assets (improvements). The former will not affect land use decisions; the latter will affect location and type of use. We assume that each jurisdiction has a choice of two types of taxes with which to finance its expenditures: a tax on land alone, and a tax on improvements. (Given the association of housing capital -- real estate improvements -- with household income, this tax has the effect of an income tax.) To the extent that the jurisdiction resorts to land taxes to finance its expenditures it will lessen the locational disadvantage of its total tax burden. Thus, we can relate the unadjusted total tax rate burden to its adjusted locationally-relevant component as follows:

$$(12) \qquad P_i^R \equiv P_i \left(1 - \frac{T_i R_i}{P_i N_i \bar{y}_i G_i} \right) \qquad i = 1, 2$$

$$\frac{T_i R_i}{P_i N_i \bar{y}_i G_i} \leq 1$$

where T_i is the land tax rate (per dollar of assessed valuation: i.e., a proportion of the value of the land)

R_i is the total value of land in jurisdiction i.

In order to close the system of determinants of residential location, we must indicate the determination of the jurisdictional distribution of business activity and the cost of inaccessibility, since these enter into the expression for $\Pi^D_{j(N_2)}$. The distribution of business activity is determined largely exogenously. We assume that in the relevant

range business desires for suburban location are limited by acreage ceilings established by the suburb's business zoning. More business would like to locate in the suburbs than are allowed. So the zoning constraint is effective for both up and down changes. Consequently, the % of SMSA business which is located in the suburb is solely a function of the suburb's zoning ceiling.[15] Thus,

$$(13) \qquad b_2 = b(Z_b) \quad 0 \leq b_2 \leq 1$$

P_D consists of the elements $V_{j(N_2)}$ $(b_2, y_{j(N_2)})$, r_1 and r_2. V expresses the household's out-of-pocket, time and convenience costs for SMSA travel. The pattern of trips is heavily influenced by b_2, and this cost is not literally identical for all suburban residents but is an average of travel costs from the suburban boundary to city destinations. The additional costs involved by residing beyond the border will be handled as an adjunct to suburban land value determination. V has an important subjective component in that, while we may assume tastes about travel convenience to be equal for all, the value of time is related systematically to household income level. Thus, for given b_2 and each N_2 -- which determines the identity of household $j(N_2)$ -- we can stipulate $V_{j(N_2)}$.

The value of city and suburban land is much more complicated. As with traditional land rent theory, we begin by assuming that rental levels (and market values as a capitalization of these) are demand-determined. Bid prices on different pieces of land depend on their differential advantages for various uses. Since we are not primarily concerned with inter-use competition for land, we assume for convenience that all land is equally good for residential use except as to accessibility.[16] Moreover,we treat accessibility simply as a function of nearness to the

city center (CBD). We wish to be able to cite a single number to represent land prices in city and suburb. For this purpose there is an important asymmetry between city and suburb.

As a preliminary, the existence of pure land taxes (T_1 and T_2) creates a backward-shifted tax-capitalization wedge between no-tax values and cum-tax values of land. The wedge is as follows:

(14) $r_i = (1 - T_i)\, g_i \quad i = 1, 2$

where r_i is the per acre market value of land in jurisdiction i in the presence of land tax T_i

g_i is the corresponding land value in the absence of tax T_i.

The asymmetry concerns determination of the no-tax values g_1 and g_2.

When the supply of land is fixed and is homogeneous, demand-determined price formation suggests that land use density is a good determinant of land prices, since it indicates the strength of competition to use the land. This corresponds to the situation of the city, with frozen boundaries and a given area, except the different locations within the city have different accessibilities. We can therefore express "the" price of land in the city as the average price over all these accessibilities for given overall density in the city.[17]

For the suburb, on the other hand, the boundaries are not fixed: the margin of urban land use there is a function of the size of the urban population, N_2. The model must reflect the phenomenon that as N_2 rises the extent of urban land use rises, and therefore that the distance of the marginal suburban use to the CBD increases. The expansibility of this boundary means that the supply of land is <u>not</u> fixed in the suburb. The ability of a potential new land user to settle on newly

urbanized land is a restriction against the ability of owners of already-settled land to raise their prices as a response to an increase in the suburban population. Thus, land rentals will not generally rise to wipe out all consumer surplus accruing to land users: users will not have to pay as much as they would have been willing to under the most stringent competition.

The only ground that established owners will have to raise rentals (market prices) as N_2 rises is that newly urbanized land will be farther out from the city center than already-urbanized land and therefore less valuable for urban use. Suburbanites will generally settle as close to the CBD as possible while availing themselves of the jurisdictional and density benefits of suburban location, other things being equal. For simplicity we assume that suburban density is approximately equal throughout (as guaranteed by uniform zoning). So the first suburbanites live just across the border, and subsequent population growth settles adjacent concentric rings. Each wave can bid outlying land away from rural use at a modicum above the rural reservation price. But in so doing it will incur differential inaccessibility relative to all suburban land closer-in. New suburbanites would be willing to compete for closer-in land and pay a price up to the rural reservation price overbid plus the cost of the relative inaccessibility. Thus, prices of closer-in land increase as N_2 increases, but only by the amount of the relative inaccessibility between the existing lot and the new outmost suburban margin. A price gradient develops in the suburb just as in the city and since, for each N_2 a given outmost margin is determined, the set of rural price overbid plus relative inaccessibility costs is determined for all suburban

land. This in turn determines the suburban land price facing the marginal suburbanite, $j(N_2)$. It is the real price of settling at the outer margin, whether or not $j(N_2)$ actually settles there; since the real rental for every location will be the same: it will be equal to the rural price overbid paid to the land owner plus actual travel cost from the outer edge to the center, or the same overbid plus a combination of actual travel cost from the actual location to the center plus the cost of travel from outer edge to the actual location capitalized in the rent paid to the landlord.[18]

The equilibrating process in the suburban land market can be seen in the following relations:

(15) a. $g_2 = g_2^S = L_{S2}\left(N_2, b_2, Z^R, Y_{j(N_2)}\right)$ $\qquad \dfrac{\partial g_2^S}{\partial N_2} > 0$

b. $g_2^D = L_{D2}(N_2, \Pi_{j(N_2)})$

c. $L_{S2}(N_2) = L_D(N_2, \Pi_{j(N_2)})$ $\qquad \dfrac{\partial g_2^D}{\partial N_2} < 0$

where

g_2^S is the suburban land supply price

L_{S2} is the suburban land supply price function

g_2^D is the suburban land demand price

L_{D2} is the suburban land demand price function

g_2^D is the highest land price that the marginal migrant, $j(N_2)$, would be willing to pay without making his net gains from migration negative: in effect, it is the price of land which would reduce his net gains to zero. Equation (15c) is therefore an alternative[19] way to specify the condition for equilibrium population distribution. It is shown in figure 1.

$\hat{N}_2$ is the equilibrium population distribution since at $\hat{N}_2$ the marginal migrant has $\Pi_{j(\hat{N}_2)} = 0$, so $\hat{N}_2$ tends to persist; at $N_{21} < \hat{N}_2$,

$\Pi_{j(N_{21})} > 0$, so more migration is encouraged; at $N_{22} > \hat{N}_2$, $\Pi_{j(N_{22})} < 0$, so migration is excessive.

Equilibrium in the suburban land market really means equilibrium in suburban <u>and</u> city land markets, since the two are competing for the same total metropolitan population. The L_{D2} function can help demonstrate suburban market equilibration because it subsumes a relation for the city market which we have discussed but not yet proposed formally—namely, the rent demand function in the city. Because of the fixity of the city land the demand price function serves to determine rent levels there. So, from our above discussion:

$$(16) \qquad g_1 = g_1^D = L_{D1}(N_1, b_2)$$

With fixed SMSA population, N, we can treat g_1 and g_2 as continuous variables in a way which directly reveals their interrelationship:

$$(15'a) \qquad g_2 = g_2(n_1, b_2) \quad . \qquad \frac{\partial g_2}{\partial n_1} < 0 \quad .$$

$$(16') \qquad g_1 = g_1(n_1, b_2) \quad . \qquad \frac{\partial g_1}{\partial n_1} > 0 \quad .$$

Thus, an increase in N_2 both raises g_2 <u>and</u> lowers g_1 and therefore, all other things equal (namely, constant T_1 and T_2), has similar effect on r_2 and r_1. An increase in N_2 decreases $r_1 - r_2$ and so increases $P_D = V - (r_1 - r_2)$.

We can now explain why, in (15) it is (15a) alone that is associated with g_2. (15b) includes the information from (16) along with the determinants of $\Pi_{j(N_2)}$; and (15c) is simply an alternative for (7). Thus, they are redundant if these other relationships are expressed separately. Only (15a) gives new information

about the land market. For any N_2 it <u>is</u> L_{S2} that will give g_2; L_{D2} and equation (15c) simply indicate which values of N_2 will tend to persist.

We must now connect land prices, r_1 and r_2, with the total value of land in each jurisdiction, R_1 and R_2. This is done by assuming a fixed area for both jurisdictions, M_1 and M_2, respectively. Then,

(17) $$R_1 = r_1 M_1$$

where M_1 is the city land area (number of acres).

For the suburb there is a complication because the urban land use development, for which we have derived r_2, may well fall short of M_2. Therefore,

(18) $$R_2 = r_2 M_{2u} + r_F (M_2 - M_{2u})$$

where
M_2 is the suburban land area (number of acres)
M_{2u} is the suburban land area in urban uses
r_F is the price of non-urban land.

As indicated earlier, each jurisdictional government attempts to maximize the productivity of the jurisdiction as a site for economic activity (including residential and business[20]) : i.e., to maximize the total value of land in the jurisdiction. For the city, with fixed urban area, this simply means to maximize r_1. For the suburb it means to maximize r_2 because : (1) urban use cannot be spatially extended without bidding land away from a non-urban use, so urban extension involves raising the <u>average</u> price of fixed area M_2; (2) urban extension results in an increase of r_2. Thus, every increase in r_2 is associated with an increase in the average price of land in the suburb as a whole, and max r_2 implies max average price, and thus total value.

Toward accomplishing their respective goals, the governments posess the following policy instruments:

central city: $(1-t_E)$ -- the % of suburban presence externality costs which are taxed away from suburbanites;

T_1 -- the proportional city tax on land alone.

suburb: T_2 -- the proportional suburban tax on land alone.

Z_R -- residential zoning regulation specifying the minimum lot size permissible for suburban residence.[21]

Z_B -- business zoning regulation stipulating the maximum acreage to be devoted to business activity.[22]

This completes the specification of the model. We now consider the equilibrating process of the system.

III. Equilibrating Process in One Jurisdiction

A. The Nature of Equilibrium Distribution

To show the equilibrating mechanism it will be convenient to make use of our assumption of constant overall SMSA population, N. Then we can use n_1 as the single functional argument wherever an absolute jurisdictional population is indicated.

The basic equilibrium condition is that $\Pi_{j(n_1)} = 0$, or that $\Pi^J_{j(n_1)} = -\Pi^D_{j(n_1)}$. The dominant characteristic of the system is that both types of suburban gain are a monotonic increasing function of household income. Jurisdictional gains for movers are by nature non-negative, but the land density component can lead to negative gains, since the positive source, the size of D, can be very low, and the negative source, $V - (r_1 - r_2)$ can be large enough to exceed D in utility significance.

Since richer households have more to gain than poorer households from suburbanization, we assume they are first to develop the suburb to urban use. With small initial n_2(large n_1) both $\overline{y}_2$, and $y_{j(n_1)}$ are very high. Also $\frac{N_{2w}}{N_2}$ is very low. Similarly D is very high. So $\Pi^J_{j(n_1)}$ and $\Pi^D_{j(n_1)}$ are very high, as is $\Pi_{j(n_1)}$. We assume the probability of a move in any period (or the speed of an adjusting move) by each household k is a positive function of the size of Π_k. So the next suburbanites are those just below the previous marginal mover in income level. Thus, as n_1 falls, $\overline{y}_2$ and $y_{j(n_1)}$ fall also, and we can predict the identities of these movers. The SMSA population migrates to the suburb in the exact sequence of the descending income level array.

The increase of n_2 therefore traces out a systematic pattern for the components of $\Pi_{j(n_1)}$. Welfare load benefits and the differential between public goods provision in the two jurisdicitons decline substantially beyond some point. The effect of interjurisdictional externalities is mixed because, while a larger suburban population imposes a larger total (and total uncompensated) externality cost (per unit of public output) on city taxpayers, and thus a larger differential price facing city and suburban taxpayer, the absolute value of this growing differential to the <u>marginal mover</u> declines because of the smaller income of successive marginal movers. On balance, the function $\Pi^J_{j(n_1)}$ (n_1) will generally begin high at $n_1 = 1$ and gently decline as $n_1 \to 0$, remaining positive throughout.

The $\Pi^D_{j(n_1)}$ (n_1) function is more striking. At values near $n_1 = 1$ D is very high, as is $\overline{y}_2$ and $y_{j(n_1)}$. So the utility significance of the privacy gain is very high, the cost of inaccessibility rather low

(r_1-r_2 is high), and the minimum lot constraint inoperative. $\Pi^D_{j(n_1)}$ begins exceptionally high. But with smaller n_1, D itself declines as well as the utility significance of each unit of D, $r_1 - r_2$ falls and the utility significance of the out-of-pocket costs of travel rises to offset the lower valuation of travel time. When N_2 is large enough $j(n_1)$ has an income level low enough for the minimum lot requirement to begin binding (especially since r_2 rises with N_2 and so makes smaller lots more attractive). Further increases in N_2, with declining $y_{j(n_1)}$, make the minimum lot requirement more and more onerous. This is doubly abetted by rising r_2, since this not only increases the losses from minimum lot zoning, it lessens $r_1 - r_2$ and therefore increases the net inaccessibility cost. At some n_1, $\Pi^D_{j(n_1)}$ will become zero. It continues downward to become negative with smaller n_1. As $n_1 \to 0$, $\Pi^D_{j(n_1)}$ becomes considerably negative.

Equilibrium n_1, $\hat{n}_1$, occurs when $\Pi^J_{j(n_1)} = -\Pi^D_{j(n_1)}$. This is shown in figure 2.

In figure 2, the shapes of $\Pi^D_{j(n_1)}$ and $\Pi^J_{j(n_1)}$ reflect some of the above discussion. We have drawn $-\Pi^D_{j(n_1)}$ to juxtapose with $\Pi^J_{j(n_1)}$. Since the equilibrium condition is $-\Pi^D_{j(n_1)} = \Pi^J_{j(n_{-1})}$ equilibrium n_1, (i.e.,$\hat{n}$) is determined where the $\Pi^J_{j(n_1)}$ function intersects the $-\Pi^D_{j(n_1)}$ function. At $\hat{n}_1$, since $\Pi^J_{j(n_1)}$ is positive, $\Pi^D_{j(n_1)}$ must be negative. To the right of this, at higher n_1, $\Pi^J_{j(n_1)} > -\Pi^D_{j(n_1)}$ so $\Pi_{j(n_1)} > 0$, and more migration occurs (n_1 becomes smaller). To the left of $\hat{n}_1$, $\Pi^J_{j(n_1)} < -\Pi^D_{j(n_1)}$, so $\Pi_{j(n_1)} < 0$, and less migration occurs (n_1 must be larger). Only at $\hat{n}_1$ itself does $\Pi^J_{j(n_1)} = -\Pi^D_{j(n_1)}$, so the marginal mover is just indifferent--the dichotomization of the population is stable.

Some properties of the equilibrium spatial distribution can be noted. $\Pi^J_{j(n_1)} > 0$, so the suburban price of public goods is less than that in the city. Similarly, the quality level of public good provision is greater in the suburb than in the city. Behind these lie a higher mean income in the suburb than in the city, a smaller proportional welfare load, and the imposition of net external diseconomies by suburbanites into city taxpayers.

$\Pi^D_{j(n_1)}$, on the other hand, is negative. The marginal mover finds that the costs of suburban living exceed the attractions of lower density living, partly because the suburban population is large enough so that overall suburban density is considerably less different from that of the city than under a much smaller suburb; partly because the rise of the suburban population has caused city rentals to fall and suburban rentals to rise, so that the relative inaccessibility of the suburb is not as strongly offset by a big land price differential favoring the suburb as under a smaller suburb; and partly because the suburban population includes households of modest enough means so that the minimum lot requirement finds them having to consume enough extra land than they would have liked as to impose a serious cost.

As far as the land market is concerned, the extension urban development frontier has proceeded to the point where the cost of the additional intra-suburban inaccessibility from frontier to the inner boundary of the suburb imposes costs on the marginal mover just great enough so that the addition to it of the non-urban land use reservation price (plus a nominal ε) just reduces the migration gains of the marginal mover to zero. Intramarginal land prices in the suburb have differentially risen to equalize the terms on which land

of different accessibilities can compete on the market.

So the equilibrium has implications for demographic differences, differences in the provision of public goods, and differences in land prices. More generally, population and land use and the economics of the public sector are all at issue.

B. Effects of the Policy Instruments

The equilibrium n_1 described referred to one particular set of values of the policy instruments. Since changes in these values can affect both the size and structure of land density and jurisdictional benefits, they will in general affect the equilibrium value of n_1.

We shall give a brief summary of the kinds of impact the policy variables are likely to have.

1. Z_R: An increase in Z_R (i.e., a lower minimum lot requirement and thus a higher population ceiling permitted in the suburb) benefits poorer, not richer households since: (a) the original Z_R was only a binding constraint on poorer households, (b) the change permits larger n_2 and thereby less net privacy benefits and lower per capita jurisdictional benefits. Passing from the top of the income distribution downward, the highest groups were not directly affected by the previous Z_R, so its loosening does not now benefit them. At some point on the array the first household that was affected will be encountered. The effect on this household will have been small, since it depends on the difference between unconstrained and constrained lot size choice: for such a household unconstained size will have been almost as great as the constrained minimum. For households with lower and lower incomes the discrepancy will be greater and greater, since unconstrained lot choice is a positive

function of income. This increasing effect continues downward throughout the remainder of the array.

The key to the effect on equilibrium depends on where the effect is "first" felt along the array relative to the initial equilibrium. Since the $\Pi^J_{j(n_1)}$ function is always non-negative, equilibrium must always be at a value of n_1 where net density benefits are negative (to be balanced by positive jurisdictional benefits). If $\Pi^D_{j(n_1)}$ reflected only minimum lot size, we could infer that $\Pi^D_{j(n_1)}$ were negative only where zoning created losses, so that the richest affected household would be marginal mover at the $\Pi^D_{j(n_1)} = 0$ value of n_1. But $\Pi^D_{j(n_1)}$ reflects as well value of privacy less the price of privacy, and this term too can be negative. Moreover, it is not certain whether the household for which <u>this</u> term first becomes negative has higher or lower income than the first negative lot size household. The problem is complicated by an interaction effect: a given $r_1 - r_2$ difference has different welfare offset to transport costs (V) depending on how large is the lot for which r_2 is paid (i.e., H^*).

If the privacy component breeds negative benefits first, the lot constraint binds only to the left of where $-\Pi^D_{j(n_1)} = 0$; if the reverse, then it binds to the right of $-\Pi^D_{j(n_1)} = 0$. This is shown in Figure 3. Each $-\Pi^D_{j(n_1)}$ function ($-\Pi^D$) begins at point A for $n_1 = 1$ and contains the segment from A to the point of first impact. At this point there is a discontinuity followed by the new segment labeled $-\Pi^{D'}$ or $-\Pi^{D''}$ or $-\Pi^{D'''}$. Where lot size binds first we have $-\Pi^{D'''}$, at the same time $-\Pi^{D''}$, and second we have $-\Pi^{D'}$. The earlier it binds the greater the impact of a change in Z_R (up <u>or</u> down), and the greater the impact on the equilibrium: n_1''' instead of n_1'' or n_1'. Finally, if the constraint is effective only

at $\hat{n}_1$, then the new lower segment of $-\Pi^D$ begins at n_1 and the equilibrium remains unchanged.

2. Z_B: Changes in Z_B affect the privacy component of $\Pi^D_{j(n_1)}$. An increase in Z_B decrease the inaccessibility of suburban location. This increases $\Pi^D_{j(n_1)}$ for all. On the presumption that the richer are more willing to commute than the poorer, benefits rise inversely with income. On the other hand the increase in business activity in the suburb for every level of n_1 decrease the amount -- and thus the value -- of suburban privacy throughout. As a luxury good, this adverse effect touches the rich much more than the poor. On balance of the two effects the richest probably lose the poorest gain. The dividing line is important to the effect on equilibrium, but is not obvious.

The situation is shown in Figure 4. A rise in Z_B causes a counter clockwise rotation around that point on the original $-\Pi^D$ where the marginal mover is unaffected by the change in Z_B. $-\Pi^{D'}$, $-\Pi^{D''}$, $-\Pi^{D'''}$ represent successively more adverse effects — and adverse effects on more households. The first two increase equilibrium suburb size (probably the "normal" case), but the third actually decreases it.

3. t_E: Compensation from suburbanites for jurisdictional externalities affects jurisdictional benefits $\Pi^J_{j(n_1)}$. If the city can raise $1 - t_E$ so that the proceeds exceed the extra costs incurred by the city residents —

$$(19) \qquad \frac{\partial[\, t_E\, E(G_1, N_1, N_2)\,]}{\partial(1 - t_E)} > C_E'\,(1 - t_E)$$

i. e., then it lowers $P_1 - P_2$ at every n_1: i.e., Π^J falls throughout, and thus equilibrium n_1 rises. Indeed, to maximize r_1 the city should raise $(1 - t_E)$ so long as (19) is fulfilled. But raising $1 - t_E$ is not

straightforward. It involves discovering or creating forms of taxes that approximate usercharges for the variety of incursions suburbanites make in the consumption of city public goods. This is difficult. Some incursions are too diffuse, some otherwise tax forms are illegal or unadministrable, and some have incidence on city dwellers as well as suburbanites, thereby leaving city resident burdens not much improved.[23] These difficulties are meant to be reflected in the $C(1-t_E)$ function. It is not difficult to imagine that $1 - t_E$ may not approach the value of unity at all closely before the extra proceeds from a new increment of $(1-t_E)$ are more than offset by the additional "administrative" costs engendered by the tax increment.

4. T_1: Increase in the land tax rate affect jurisdictional benefits by decreasing $P_1^R - P_2^R$ for each n_1, thereby lowering the Π^J function throughout. This has the effect of increasing n_1.

There is also an impact on the Π^D function, and in the same direction. Through equation (14), the increase in T_1, all other things equal, tends to decrease r_1 via backward-shifting capitalization. This decreases $r_1 - r_2$ and so increases P_D, which means a decrease in each $\Pi_j^D(n_1)$. This too tends to increase n_1. Of the two effects, that through the Π^J function is more direct and probably more powerful. (We shall see below, however, that the city government's target, r_1, is <u>not</u> a monotonic increasing function of T_1). The situation is shown in Figure 5. Again, the original functions are unprimed and the impacted functions are primed.

5. T_2: The analysis here is symmetric with that of T_1. One effect of an increase in T_2 is on $P_1^R - P_2^R$ as a function of n_1. A rising T_2 increases $P_1^R - P_2^R$ for each n_1, and therefore raises the Π^J function. In consequence, equilibrium $\hat{n}_1$ falls. The other effect is on $r_1 - r_2$:

by decreasing r_2 it increases $r_1 - r_2$, thereby decreasing P_D and so increasing $\Pi^D_{j(n_1)}$ for each n_1. This too tends to decrease $\hat{n}_1$. The situation can be seen in Figure 5 by reversing the primes. Thus, T_1 and T_2 are exactly competitive policy tools for their respective governments, although, as we shall see below, while they do have oppposite, they do not have equal effects on $\hat{n}_1$.

IV. General Equilibrium

In this section we are concerned with the interaction of the two jurisdictions in seeking to maximize respective land values. The scope of the paper will not permit a consideration of general equilibrium with the full panoply of all policy instruments. We shall therefore concentrate on the respective use by the two jurisdictions of T_1 and T_2, where the competition of the two is most obvious. The use of t_E by the city government is only very slightly -- if at all -- interactive. The government will push $1 - t_E$ as far as its marginal proceeds exceed marginal "collection costs" -- and this is essentially independent of the suburb's use of its policy instruments. So we may assume that in the course of seeking to maximize its land values the city sets $1 - t_E$ at its unique optimum value, independently of its use of T_1 or of the suburb's use of T_2, Z_R and Z_b.

Our concentration on T_1 and T_2 therefore amounts to giving inadequate attention to the interactive effects of T_1 and T_2 on Z_R and Z_B, and vice versa. Despite this, the analysis of T_1 and T_2 should give the flavor of many of the issues involved in general equilibrium. Since the author's analysis of the model is not complete, the present paper is advanced only as a step toward the understanding of the model. It

does not pretend to be a complete realization of it.

We begin with the respective impacts of T_1 and T_2. Given t_E, and initial values of T_1, T_2, Z_R and Z_B, T_1 will be set so that:

$$(20) \qquad \frac{\partial r_1}{\partial T_1} = \frac{\partial (1 - T_1)\, g_1}{\partial T_1} = 0 \text{ or } (1 - T_1)\ \frac{\partial g_1}{\partial T_1} = g_1$$

Thus, if at initial T_1 $\quad (1-T_1)\ \frac{\partial g_1}{\partial T_1} > g_1$, T_1 will be increased

$(1-T_1)\ \frac{\partial g_1}{\partial T_1} < g_1$, T_1 will be decreased

$(1-T_1)\ \frac{\partial g_1}{\partial T_1} = g_1$, T_1 will be left unchanged

While $\frac{\partial r_1}{\partial T_1}$ is a complicated expression,[24] we can with some confidence trace out a typical relationship between r_1 and T_1. For given value of T_2, at low values of T_1, g_1 is low and, partly because of $(1-T_1)$ and partly because of $\frac{\partial g_1}{\partial T_1}$, $(1-T_1)\ \frac{\partial g_1}{\partial T_1}$ is high. As T_1 rises through higher and higher values, the first rises in absolute terms and the second declines. There comes a value of T_1 at which the two are equal; so $\frac{\partial r_1}{\partial T_1} = 0$, and r_1 reaches a maximum. Thereafter $\frac{\partial r_1}{\partial T_1}$ becomes negative. This shape is shown in Figure 6. The value $\hat{T}_1$ is where, for given T_2, r_1 is a maximum.

The same analysis applies to T_2.[25] It will generally be the case that $\frac{\partial r_2}{\partial T_2}$ begins high, gradually decreases with increasing T_2, becomes zero and then negative. The sam shape shown for r_1 and T_1 in Figure 6 holds here.

Thus, with given values of the other policy variables, each jurisdiction will generally discover an interior optimum value of T_1: neither $\hat{T}_1$, nor $\hat{T}_2$ is either zero or unity. What is the effect on this

optimum $\hat{T}_i$ if the other jurisdiction should have a different land tax rate? Given the complexity of the cross partial derivatives $\frac{\partial^2 r_1}{\partial T_1 \partial T_2}$ and $\frac{\partial^2 r_2}{\partial T_2 \partial T_1}$ there is no unique anser. In general a change in given T_2 will change the optimal $\hat{T}_1$; similarly a change in given T_1 will change the optimal $\hat{T}_2$. But it is not even possible to say whether the change will be a rise or fall: the signs of the cross partials are not unique. Indeed, it is not only possible, but reasonable, for the sign of either to be positive for some T_1, T_2 pairs and negative for others.

This wide range of possibilities is unfortunate because the pattern of signs determines the stability of the interaction syste. Suppose we begin the system at some hypothetical position: jurisdiction 1 has set t_E at its independently optimal level, and jurisdiction 2 has exogenously set Z_R, Z_B and T_2. Assume that after a certain period necessary to perceive, comprehend and arrive at a public policy decision, jurisdiction 1 sets its T_1 at the optimum for that situation. Now the same kind of interval passes while jurisdiction 2 decides on its best new value of T_2, $\hat{T}_2$ -- changing its value from the initial arbitrary level. The change in T_2 changes the optimal T_1 and it is therefore changed; this changes the optimal T_2 and it is changed. Is there convergence in this system, so that it will come to rest at some $(\hat{T}_1, \hat{T}_2)$, where each value is compatible with the other, or will the two jurisdictions continue their interactive oscillations indefinitely? The answer depends on the pattern of response that each makes to changes in the other: the reaction functions.

Figure 7, a-d, show four possible paris of reaction functions. In each $\hat{T}_1(T_2)$ is the function showing the optimal value of T_1 for every hypothetical value of T_2; $\hat{T}_2(T_1)$ is the function showing the optimal value of T_2 for every value of T_1. Figures a and c are unstable, in that, whatever the starting point, the series of consecutive adjustments of each to the other draws the oscillations farther and farther away from the intersection of the two functions. Only if the initial position had accidentally been at the intersection would it stay there. The slightest discrepancy, however, and the system would flee the intersection. No stable mutual equilibrium exists for these situations. Figures b and d represent stable systems. Whatever the starting position, the successive mutual adjustments will converge toward, and reach,the intersection. The intersection here represents a genuine stable joint equilibrium.

As indicated above, no unique shape can be predicted for our two jurisdictions' reaction functions. However, analysis of the cross partial derivatives suggests an asymmetry of response between city and suburb, reflecting in part the different specialized roles of the two: high-density, high accessibility for the one, low density, less accessibility for the other, with different policy instruments appropriate to carrying out these roles. It suggests that a reasonable pattern of reaction may be that shown in Figure 8.

Here $\hat{T}_1(T_2)$ is monotonic rising, with positive T_1 intercept. $\hat{T}_2(T_1)$, on the other hand, falls for low values of T_1 and then rises only for high values of T_1. This pattern of interaction is convergent. So the system is stable and the intersection of functions defines a true joint equilibrium, $(\hat{T}_1, \hat{T}_2)$. It is important to notice that this is an interior equilibrium: neither $\hat{T}_1$ nor $\hat{T}_2$ equals zero or unity. Moreover, this will result in an

interior equilibrium population distribution: niether jurisdiction will attract the whole population. This model, with this type of interactive pattern, will generate corner solutions only by rare accident.

Having begun with an optimal t_E and some exogenously given Z_R and Z_B, we see that under some conditions we obtain stable values of $\hat{\hat{T}}_1$ and $\hat{\hat{T}}_2$, and therefore also, of $\hat{\hat{n}}_1$ and $\hat{\hat{r}}_1$ and $\hat{\hat{r}}_2$ (where, as usual, the double "hat" denotes the jointly compatible values). Will these latter equilibrium values change if Z_R and Z_B change? Yes, generally, since as discussed above, both instruments affect the level and shape of the Π^J and Π^D functions, and will therefore elicit new sequences of interactions. Only from such interactions can optimal values of Z_R and Z_B be arrived at also. In sum, the true stable maxima for r_1 and r_2, if they exist at all, are obtained only by the simultaneous determination of all policy variables at their jointly optimal levels, with complex interactive relations existing between zoning and taxing instruments.

VI. Comments in Comparative Statics

A. Balance of Power

1. The Use of T_1 and T_2

T_1 and T_2 are highly symmetric types of policy instruments for their respective jurisdictions. But their use involves two asymmetries between the central city and the suburb. First:

$$(21)\qquad \frac{\dfrac{\partial (P_1^R - P_Z^R)}{\partial T_1}}{\dfrac{\partial (P_1^R - P_2^R)}{\partial T_2}} = \frac{\dfrac{R_1}{N_1\bar{Y}_1}\left(\dfrac{\partial G_1}{\partial P_1^R} \quad \delta P^R - \delta G\right)}{\dfrac{R_2}{N_2\bar{Y}_2}\left(\dfrac{\partial G_2}{\partial P^R} \quad \delta P^R - \delta G\right)} \gtrless 1$$

for each n_1 and if one makes the reasonable assumption that $\frac{\partial G_1}{\partial P_2^R} = \frac{\partial G_2}{\partial P_2^R}$,

then

$$\text{(21')} \qquad \frac{\dfrac{\partial\,(P_1^R - P_2^R)}{\partial\, T_1}}{\dfrac{\partial\,(P_1^R - P_2^R)}{\partial\, T_2}} = \frac{\dfrac{R_1}{N_1\bar{Y}_1}}{\dfrac{R_2}{N_2\bar{Y}_2}} = \frac{R_1}{R_2}\;\frac{N_2\bar{Y}_2}{N_1\bar{Y}_1}$$

and the ratio changes in general for different n_1. Although their impact mechanisms on the attractiveness of suburban location are exactly opposite, their opposite effects are not generally equal or even dependably related in a simple way.

Thus, the effectiveness of T_1 and T_2 in changing the relative attractiveness of suburban location are not equal. But further, the effect of induced migration upon rentals may not be equal either. At the differential land densities between city and suburb in the relevant range, city rentals are likely to be more responsive to small population shifts (a given number of migrants changes absolute densities more in the city than in the suburb because of the latter's much larger area). Thus, equation (22) is likely to hold in much of the relevant range.

$$\text{(22)} \qquad \left|\frac{\partial g_1}{\partial n_1}\right| > \left|\frac{\partial g_2}{\partial n_2}\right|$$

Granted the uncertainty connected with the first assymetry, T_1 may on the average be a more effective instrument than T_2 for increasing rentals in absolute terms.

2. The Use of Z_R and Z_B

These zoning instruments have an effect generally opposite to that of T_1. Their possession by the suburb but not by the city -- not because they are unavailable but because they would be unavailing, since the residential and business demand for urban land do not have the specialized character that they have for suburban land, given the presence of the city -- offset the somewhat greater effectiveness of T_1 relative to T_2.

3. Density

There is, however, a further constraint on the suburban government in the context of bargaining rivalry with the central city government. While the latter seeks the highest density possible in trying to maximize r_1, the prospect of very high densities beyond some point might induce reverse migration, thereby actually tending to lower r_2. An important -- but of course not sole[26] -- source of the intensity of demand for suburban land is low density use (privacy) and this is lost at high values of n_2.

B. Broad Influences on the Outcomes

1. The greater the degree of income inequality in the metropolitan area, the greater will be the size of suburban benefits and thus the higher will be $\frac{\hat{r}_2}{\bar{r}_1}$. At the same time the suburban population may be larger than otherwise, since $\Pi_{j(n_1)}$ is a positive function of income inequality. But the larger size of n_2 is only a possibility, because in some ranges of n_2 and under certain overall circumstances, very high income households may outbid new entrants for use of suburban land (through both outright land market competition and appropriate zoning) in order to preserve low density.

2. The higher is average household income in the metropolitan area the greater are likely to be $\frac{\hat{r}_2}{\hat{r}_1}$ and n_2. Since privacy is a luxury good an increased $\bar{y}$ which reflects generally increasing living standards in the population will increase the number of people who can afford to buy privacy and the price they are willing to pay for it. This will be stymied only if the higher $\bar{y}$ reflects primarily improvement at the very top — greater inequality of income -- for then the outbidding effect under # 1 above can occur.

3. Industrialization of the suburbs through moderately higher b_2 may raise n_2 and with it $\frac{\hat{r}_2}{\hat{r}_1}$, again depending on income distribution considerations: i.e. whether the value of suburban land for privacy is greater than for general urban development, or vice versa (as in the central city). The ambiguity about n_2 and greater $\frac{\hat{r}_2}{\hat{r}_1}$ is nourished by the fact that higher b_2 involves a decrease in the per capita generation of interjurisdictional externalities $\left(\frac{\partial^2 E}{\partial n_2 \partial b_2}\right)$, since the suburb becomes more self-sufficient with respect to employment, shopping and recreation. This decreases the whole $\Pi_{j(n_1)}$ function by lessening the $P_1^R - P_2^R$ and differentials. As a result, there is a downward impact on $\frac{\hat{r}_2}{\hat{r}_1}$ and n_2.

4. The greater the assortment of local taxes used by the central city the lower is apt to be $\frac{\hat{r}_2}{\hat{r}_1}$ and n_2. This stems from the fact that a richer assortment of revenue tools can increase $1 - t_E$ at low cost, therefore decrease $t_E E$ and thus $P_1^R - P_2^R$ and $G_2 - G_1$ and so lessen the suburbanizing impetus given by the generation of inter-jurisdictional externalities.

VII. The Effect of Jurisdictional Separatism

Finally, we may briefly comment on what effect the existence of jurisdictional separatism has on the pattern of metropolitan development, In our model we have separated the suburbanizing forces into two categories -- the land density factors and the jurisdictional factors. The latter in fact owe their existence entirely to the existence of a separate suburban political jurisdiction, with no responsibility to, or dependence on, the central city's government. It is this that allows unequal spatial distribution of welfare clients and income generally, and spatial cross-over uses, to create an inequality of political opportunity ($P_1^R - P_2^R > 0$). The very same spatial distribution and set of cross-over uses[27] would not generate suburbanizing pressure through political inequality if the metropolitan area comprised a single local political jurisdiction.

We can examine how much difference this would make to our general equilibrium outcome by considering the consequences of merging jurisdictions and thus wiping out jurisdictional advantages. We should expect that there would remain what we have called land density grounds for suburban development. This has two components: (1) the value of privacy (lower "natural" use density, augmented by minimum lot zoning), (2) a price arbitrage, involving the land price differential relative to the cost of inaccessibility ($r_1 - r_2$ versus V).'

There is an ambiguity in this formulation. Minimum lot zoning certainly is part of the complex of the suburb's privacy advantage. But it probably owes its existence in the real world to the existence of the separate suburban jurisdiction. One could conceive of a single metropolitan-

wide government setting zoning restrictions to preserve specialized locational characteristics, but such restrictions would likely be far less extensive and constraining than under a separate suburban jurisdiction (remember the competitive function of Z_R in maximizing r_2).

Accordingly, we shall examine two possible variants of the problem: first, assuming that the same Z_R is in effect with or without separate jurisdictions; second, assuming that minimum lot zoning is absent under separate jurisdictions. In each of the variants we ask: what will happen to our previous general equilibrium outcome if jurisdictional benefits are eliminated? <u>Variant I (Z_R and Z_B[28] intact)</u>

The situation is shown in Figure 9. Suppose the general equilibrating process established $-\Pi^D_{j(n_1)}$ and $\Pi^J_{j(n_1)}$ as the equilibrium functions. Then the general equilibrium is at n_1, with $-\Pi^D_{j(n_1)} = \Pi^J_{j(n_1)}$. Now jurisdictions are merged, so all jurisdictional advantages, shown as the height of the $\Pi^J_{j(n_1)}$ function, disappear. The new equilibrium occurs where the marginal mover derives zero net benefits from the density use complex alone -- shown as $-\Pi^D_{j(n_1)}$. So equilibrium population shifts to n_{10}, where $-\Pi^D_{j(n_1)} = 0 = \Pi^D_{j(n_1)}$. In summarizing the consequences of this merger we shall at the same time be inidicating (by conceiving the reverse operation) what difference the existence of jurisdictional separateness makes in the model. The effects of merging are:

(a) A change in equilibrium n_2: n_1 increases from n_1 to n_{10} (i.e., suburban population falls by this amount).

(b) A change in δG: $\delta P^R = 0$, the discrepancy in public good output between city and suburb disappears. Insofar as per capita income still differs between city and suburb, the suburbanites would still <u>prefer</u> a higher public good output then city dwellers; but since under a single jurisdiction only a single jurisdiction only a single, majority-rule determined output is provided, no difference in actual output occurs.

(c) A redistribution of real income (welfare): (1) For the top n_2 in the income array the loss of the separate jurisdiction causes

(23) this welfare loss = $\frac{1}{2}\bar{Y}_2 \ (\overline{\delta P}_1^R) \ (\overline{\delta G}_2)$

where $\overline{\delta P}_2^R \equiv \bar{P} - P_2^R$, $\overline{\delta G}_2 = G_2 - \bar{G}$,

$\bar{P}$ being the price of public goods in the single jurisdiction metropolitan area as a whole.

$\bar{G}$ being the output of public goods in the single jurisdiction metropolitan area as a whole.

when price rises to that level reflected by the single jurisdiction tax rate.

(2) For the bottom n_1 in the income array the loss of the separate jurisdiction caus

(24) this welfare gain = $\frac{1}{2}\bar{Y}_1 \ (\overline{\delta P}_1^R) \ (\overline{\delta G}_1)$

where $\overline{\delta P}_1^R \equiv P_1^R - \bar{P}$, $\overline{\delta G}_1 \equiv \bar{G} - G_1$

when price falls to that level reflected by the single jurisdiction tax rate.

So merger leads to a progressive redistribution (separation leads to a regressive income redistribution).

(d) A decrease in resource allocation inefficiency: inter-jurisdictional externalities led to an excess per output unit cost of $t_E E/G_1$ which represents a deadweight loss in the efficiency of resource allocation (because it promoted inappropriate incentives for using resources). Merger succeeds in internalizing the externalities arising from spatial cross-over uses and thereby eliminates the resource inefficiency.

(e) Effect on land prices: r_2 will fall, since it is now influenced by density benefits and inaccessibility costs only, with no additional demand fillup given through jurisdictional benefits.

Variant II (Z_R and Z_B absent)

The situation is shown in Figure 9 also. Here, however, instead of the $-\Pi^D$ remaining unchanged, political merger will end privacy-protecting

residential and business zoning, so that the gains from differential density are no longer so marked (e.g., for the same n_2 there may be much larger b_2 than in the presence of Z_B. This will tend to decrease the size of positive benefits arising from density considerations since only privacy benefits which can persist without zoning protection will remain. On the other hand, the absence of minimum lot zoning means that poorer households can establish themselves on smaller lots (with resulting higher density land use for any n_2) without penalty. No one need sustain any loss on density account for there is no longer a minimum lot loss, and since privacy is the only remaining source of relative attractiveness, relative rentals must adjust downward to offset any remaining inaccessibility, so that the price of privacy cannot exceed the value of privacy. Therefore negative $\Pi^D_{j(n_1)}$ disappears and equilibrium exists where $\Pi^D = 0$ on a wholly non-negative Π^D function. Figure 9 shows the counterclockwise rotational shift in the $-\Pi^D$ function. As in Variant I, $\Pi^J_{j(n_1)} = 0$ throughout, so the equilibrium shifts to n'_{10}. This is likely to imply a smaller suburban population than under separate jurisdictions with zoning, but larger than under Variant I with zoning. Density in the suburb will probably be higher for each given suburban population size, because there is likely to be more business activity, and because the pattern of residential use is likely to involve smaller lots. Partly because of constraints against perfect mobility of business activity, some inaccessibility will persist at $n_2 = \frac{1}{2}$, whereas privacy will essentially have disappeared, so equilibrium n_1 is likely to exceed $\frac{1}{2}$. The income redistributive effect is the same here as under Variant I. Some income stratification between city and suburb, but less than under Variant I, will persist, although the suburb will become much more similar to the city with respect to density.

The difference between Variants I and II is even greater than this in a less restricted model. In this model, by assuming away the influence of tastes and demographic characteristics on location decisions we have made income level the only source of difference in these decisions. We have made zoning superfluous in determining the relative attractiveness of suburban over city location for different households: the richer will always prefer the suburbs more than the poor. Zoning in this model only sets an absolute scale for these relative attractions -- thus helping to provide a cut-off point but not affecting the order of households in the preference queue. In a more general model where tastes can differ for reasons other than income level the existence of zoning makes income level a more important determinant than it would otherwise be. So the abolition of zoning would weaken income as a self-selector of suburb-vs.-city location, and income heterogeneity would be much more marked in the suburb. But then relative density would be affected as well, with the upshot that a specific specialized low-density role for the suburbs could not be maintained (unlike in the present model under Variant II, where some specialization remains). The reallocative results would thereby be far greater than in the present model. In short, zoning has much less bite in the present model than it would if additional demographic determinants of location were admitted (a perfectly reasonable extension). So the difference between Variants I and II is potentially considerably greater than is seen here.

In sum, within this model, the possibility of establishing a separate suburban political jurisdiction enlarges the suburbs, increases

its land values, creates a divergence in the quality of public output between city and suburb, brings welfare gains to the wealthy at the expense of the poor, and permits resource use inefficiencies to develop as a result of spatial cross-over uses.

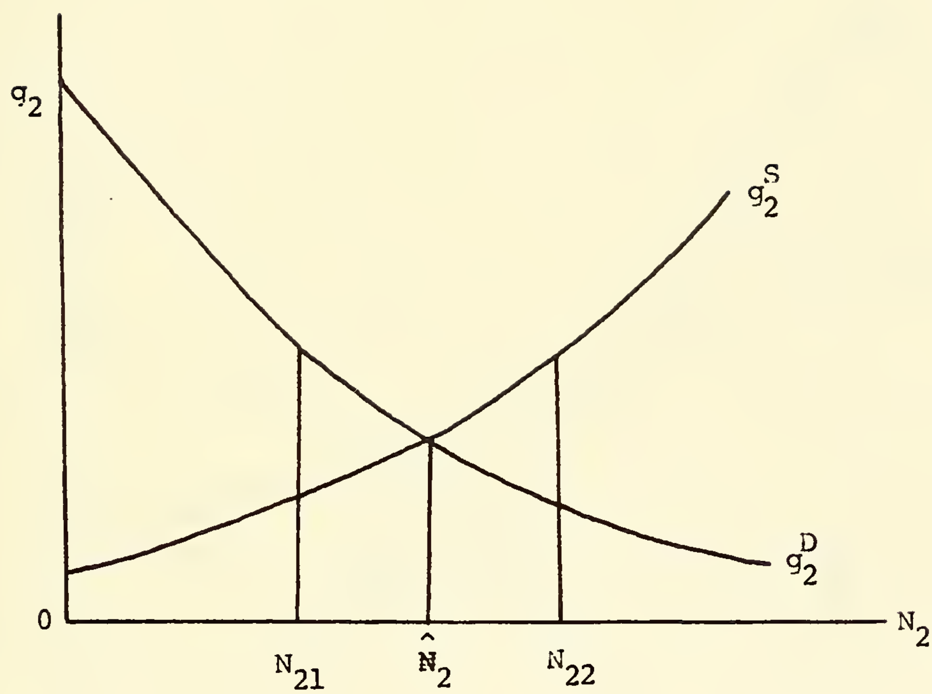

figure 1

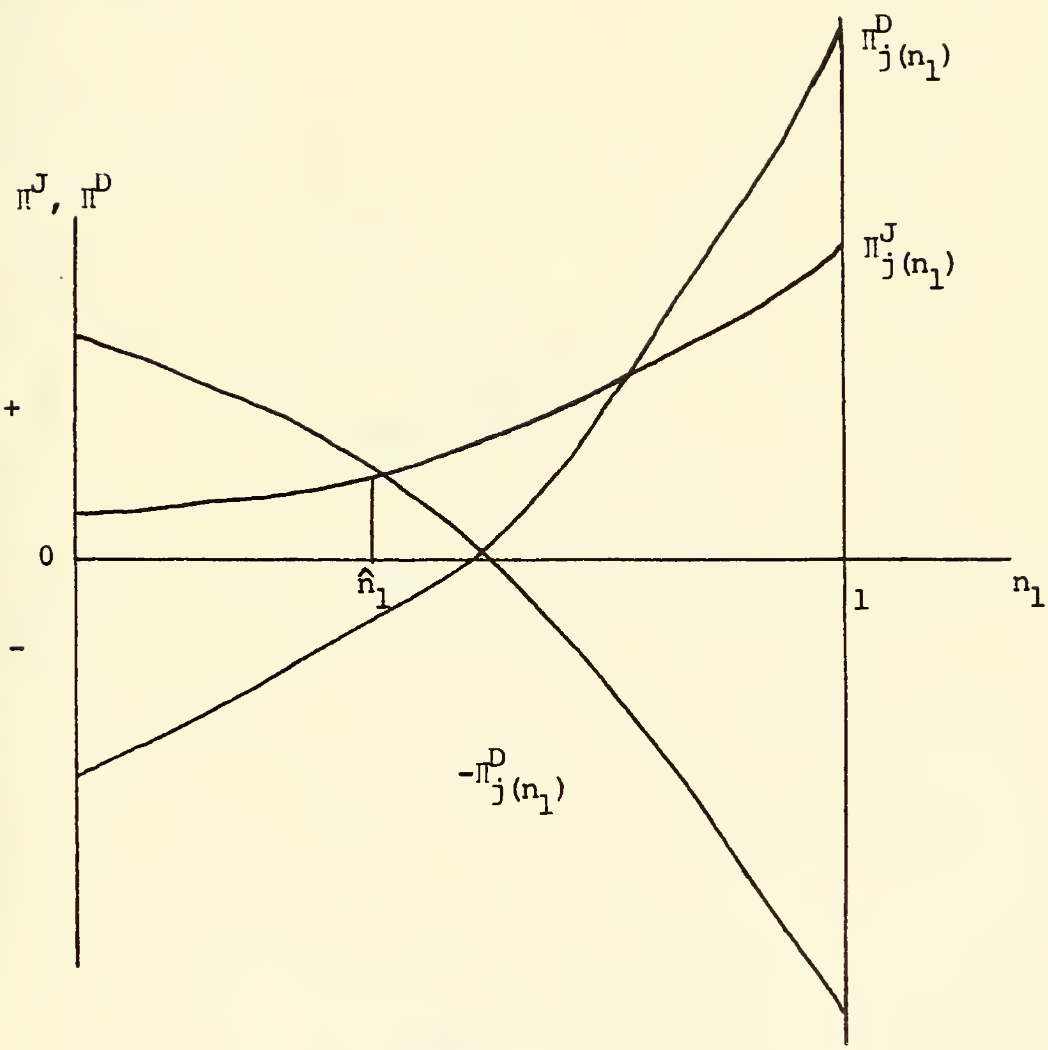

figure 2

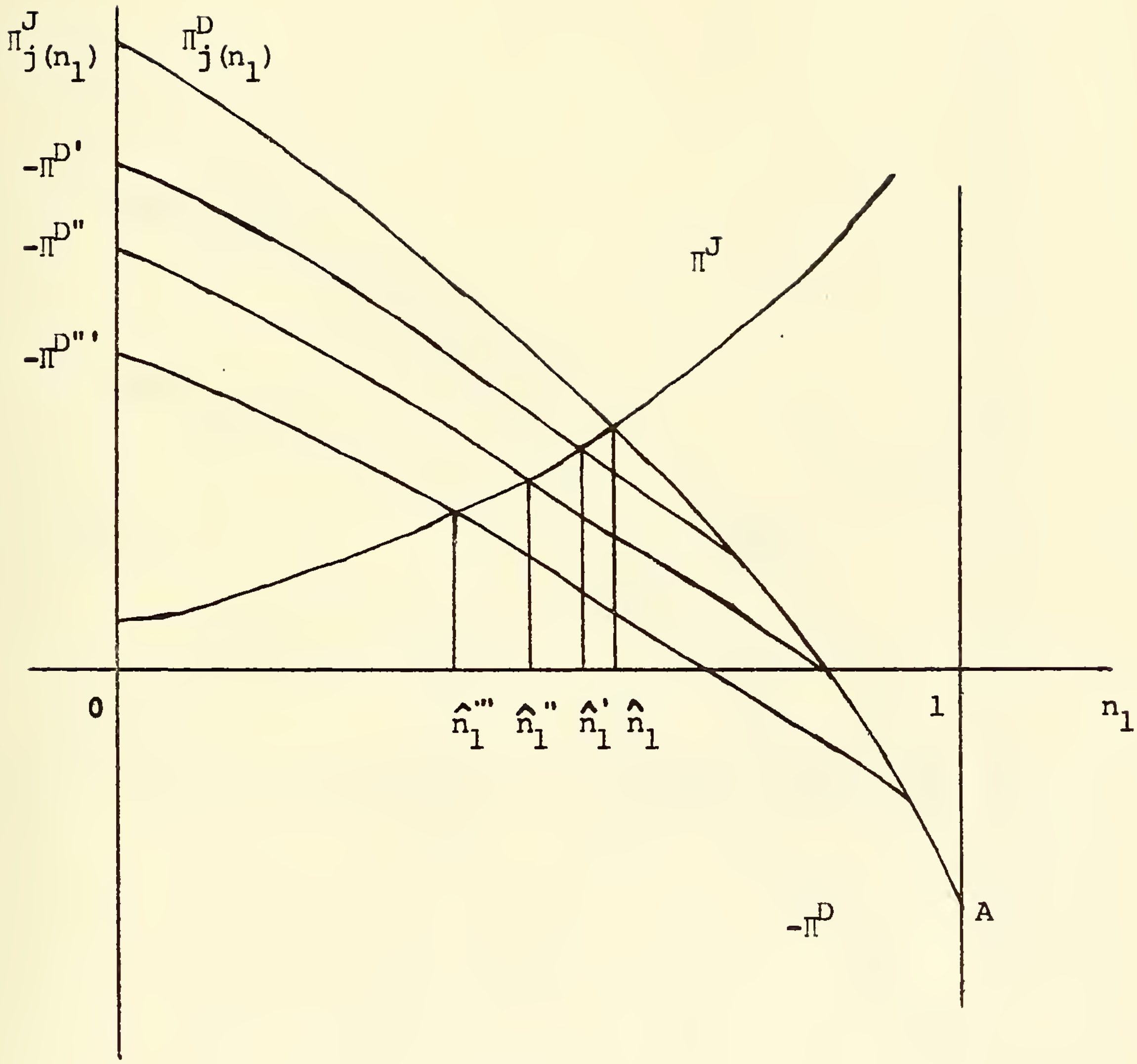
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figure 3

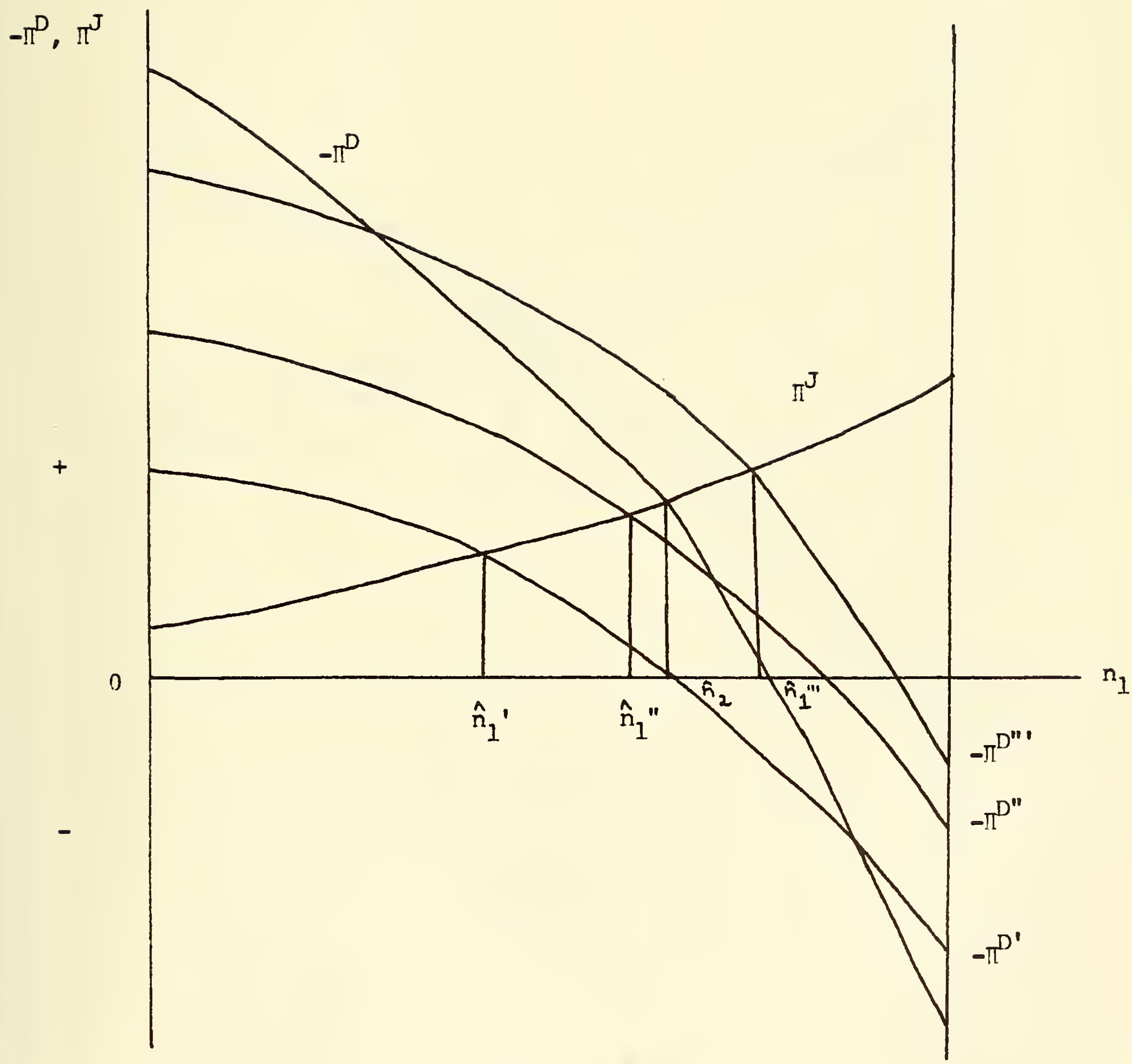
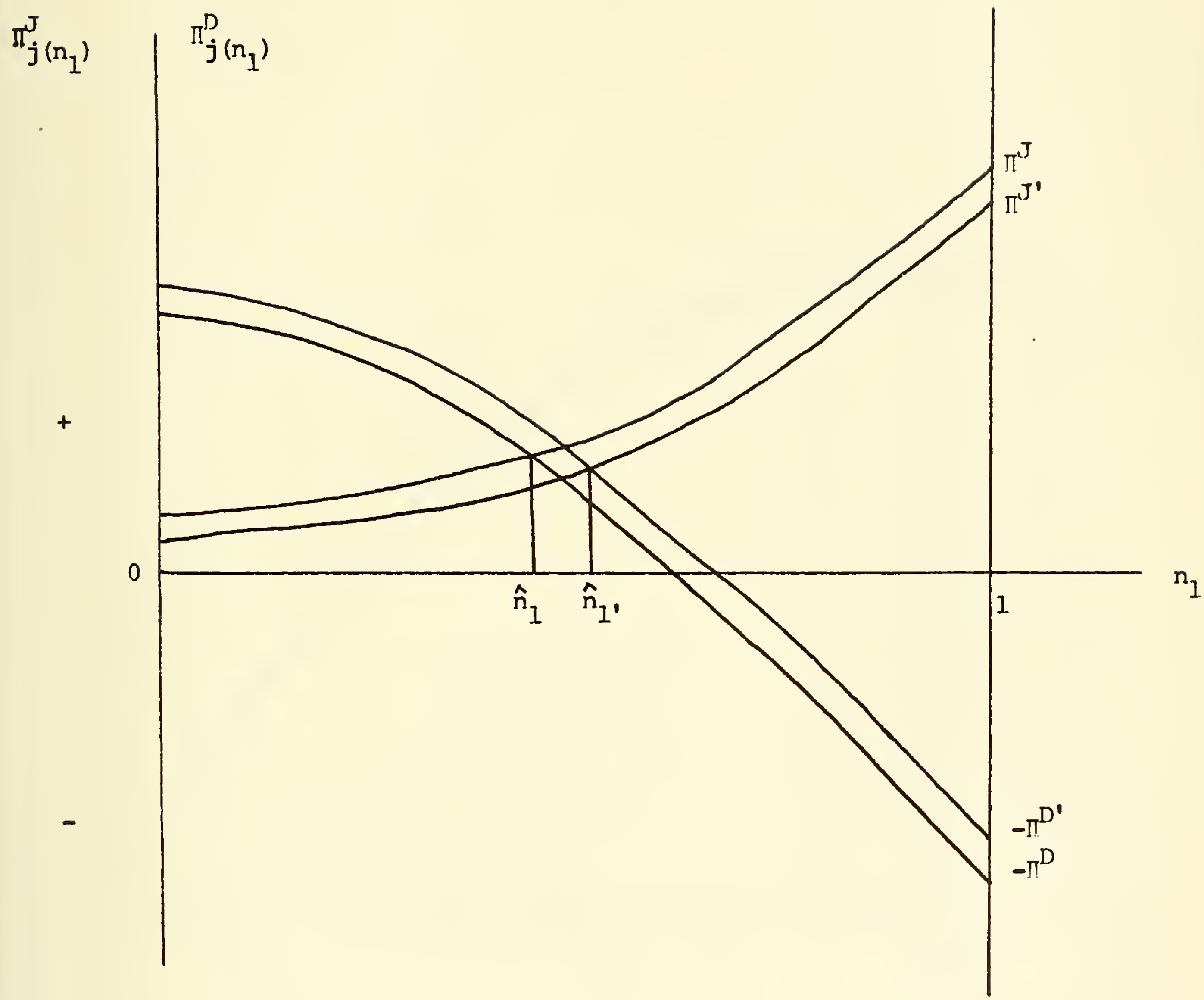


figure 4



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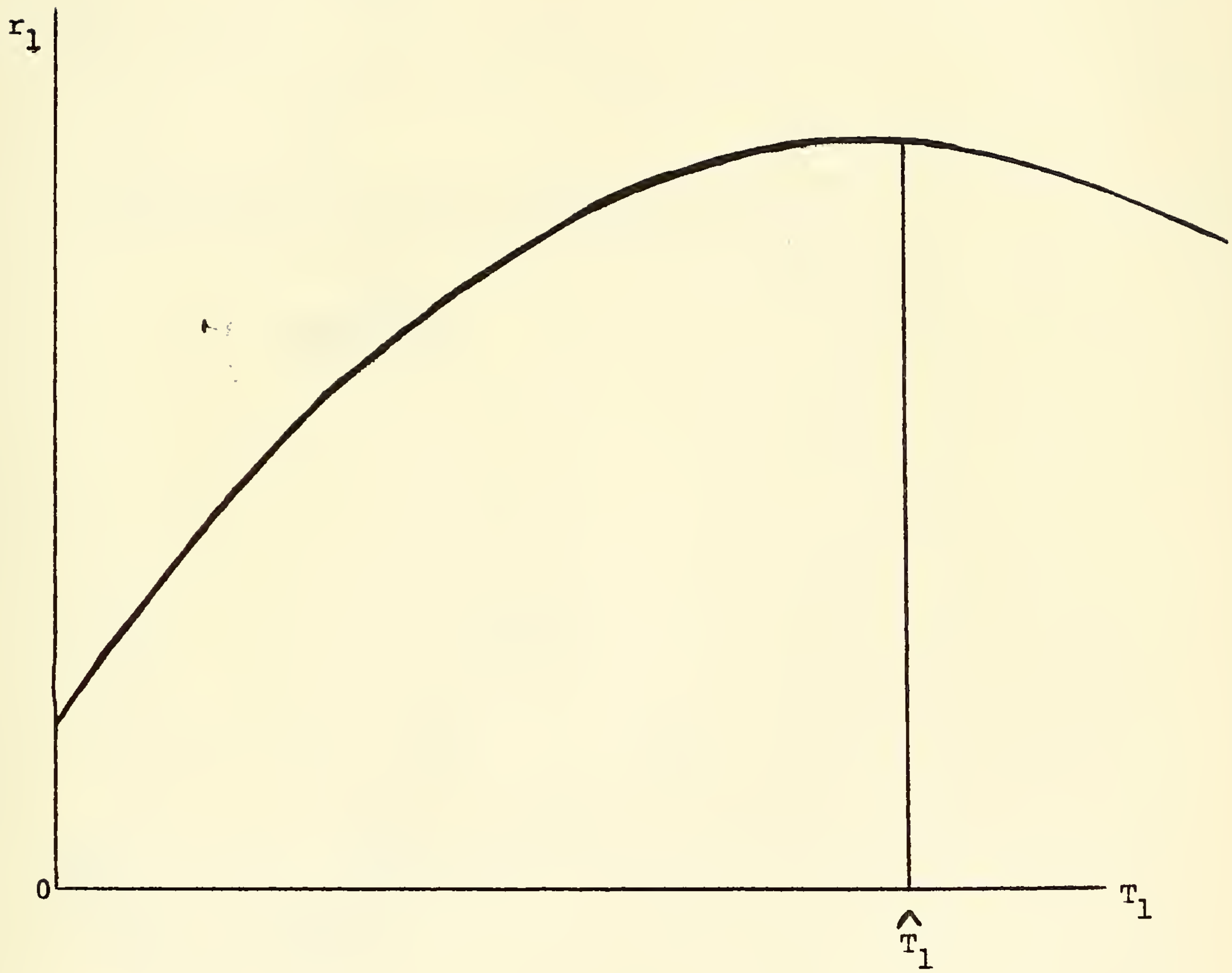

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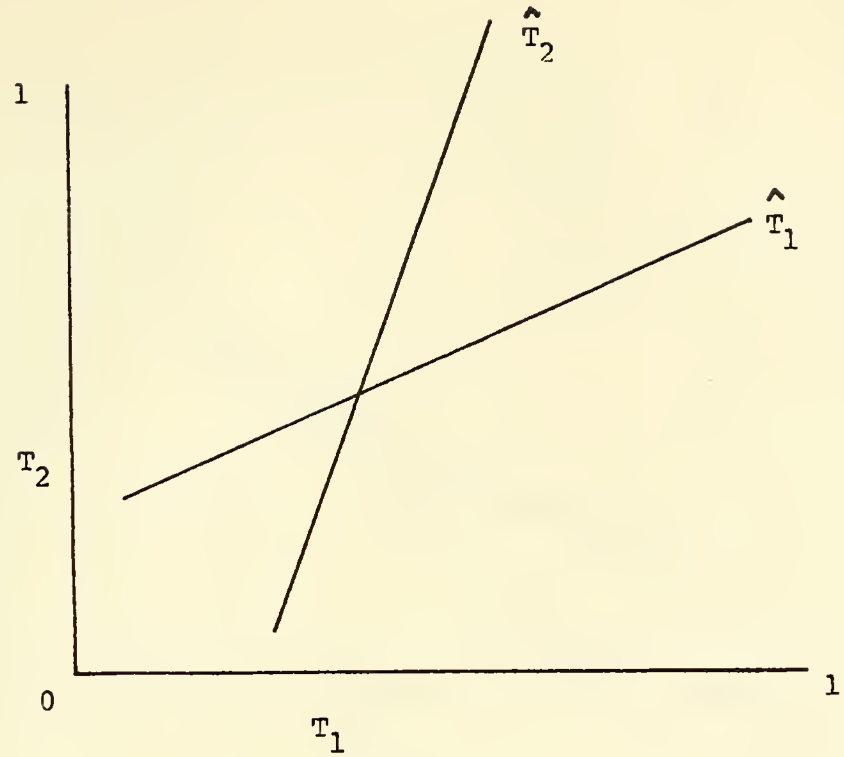

figure 7a

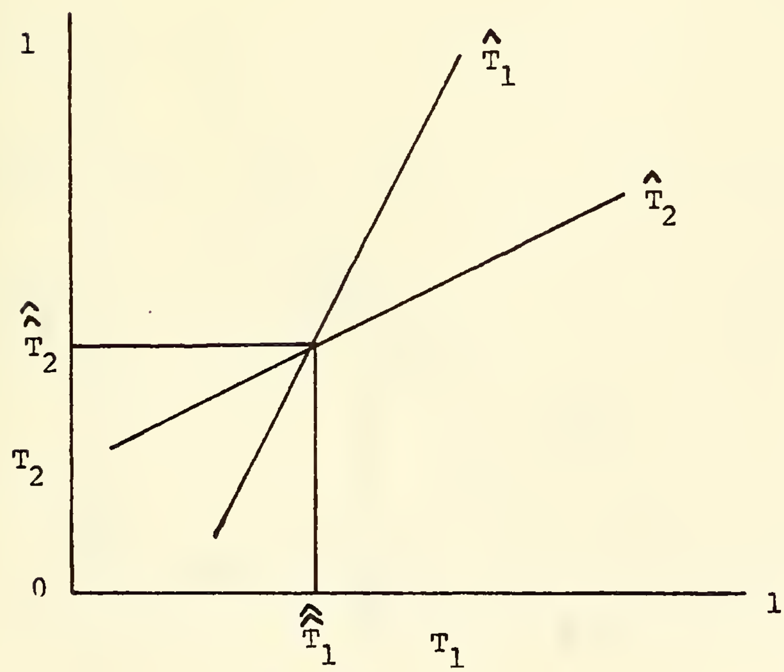

figure 7b

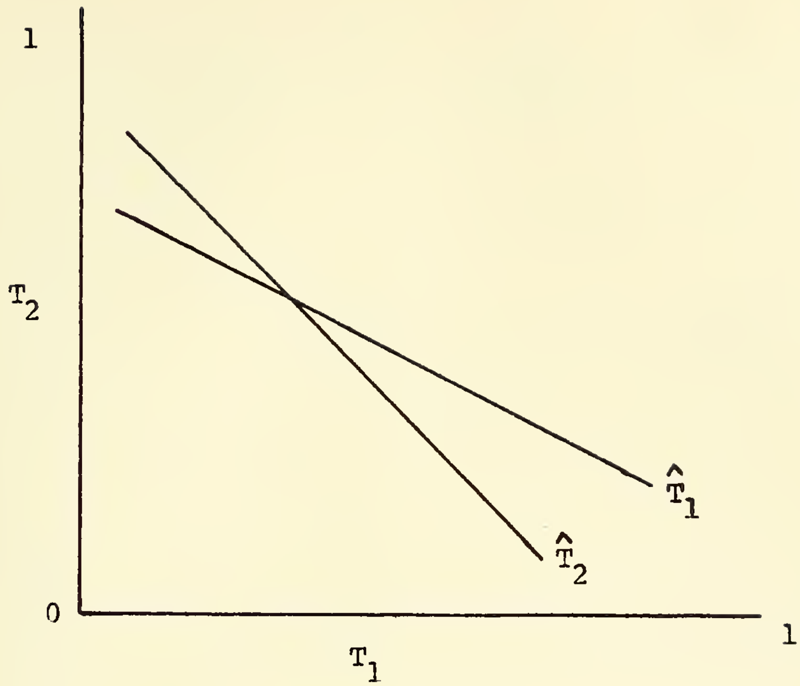

figure 7c

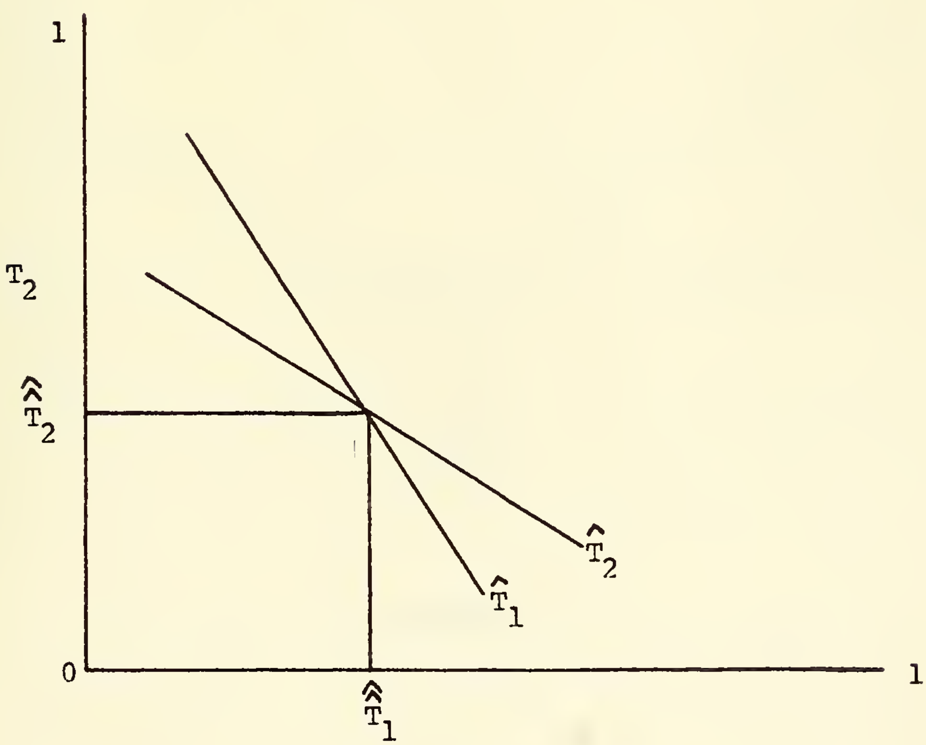

figure 7d

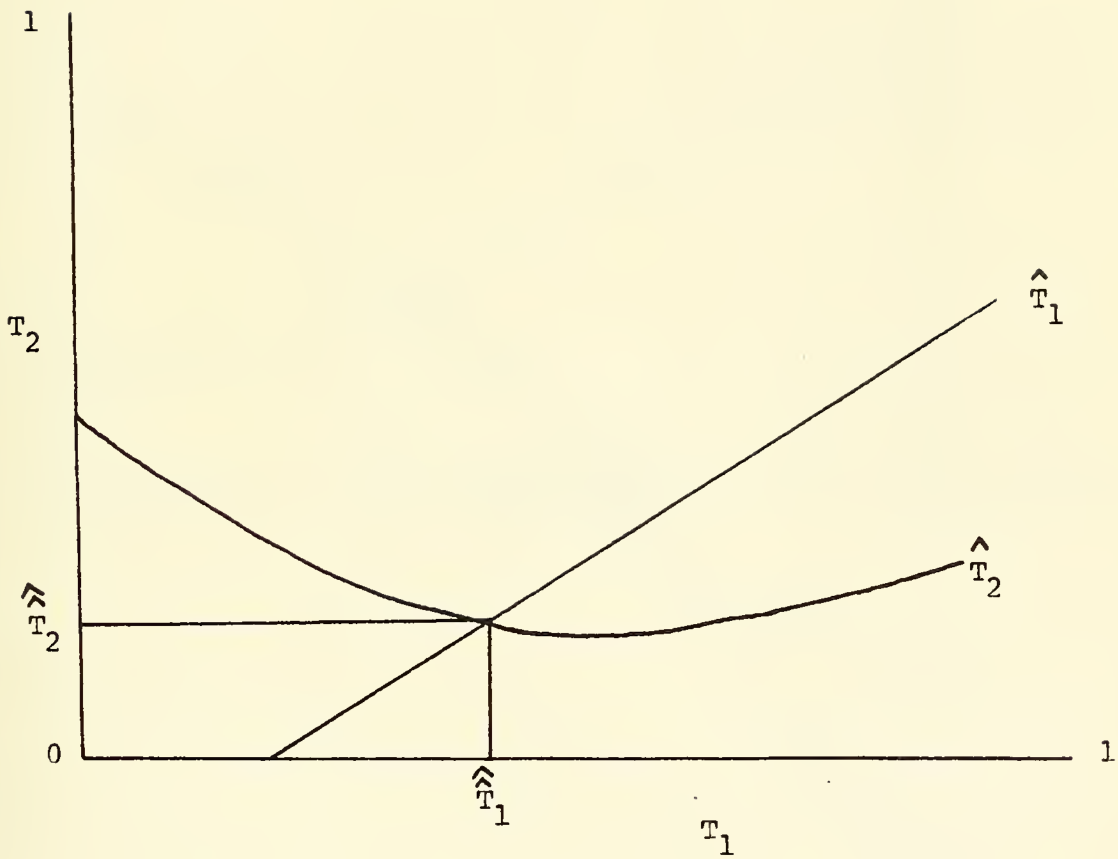

figure 8

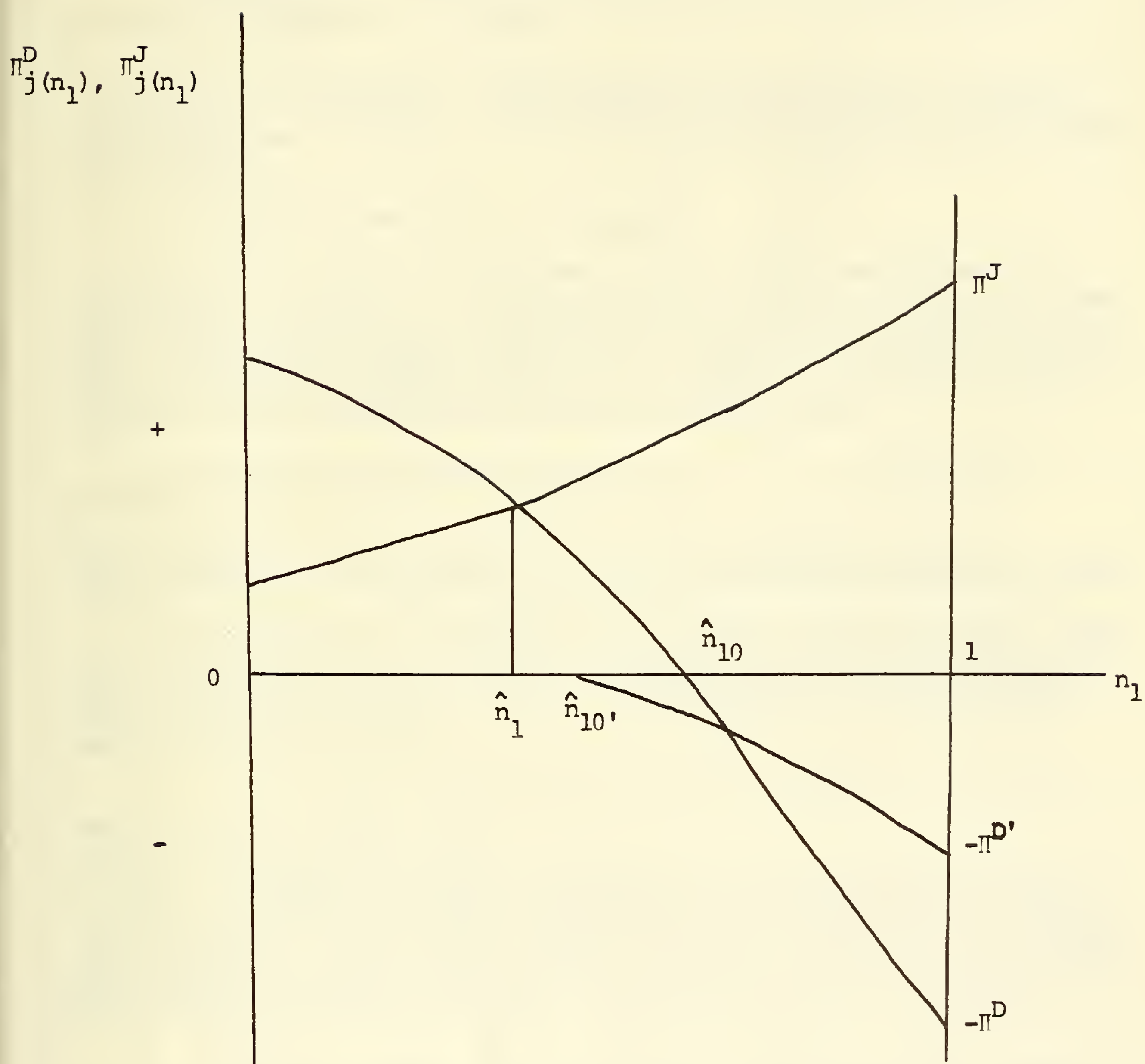

figure 9

Notes

1. A related, but quite different, model is given in the author's "Strategic Interaction and Resource Allocation in Metropolitan Intergovernmental Relations," American Economic Review, Vol. LIX, No. 2 May, 1969), 495-503.

2. Migration is not difficult to append, but the issues presented here are not affected by its absence.

3. Here too, realistic variation can be introduced without disturbing the essence of the argument. Their exclusion allows a point of departure which enables one to separate out a pure governmental impact from demographic considerations.

4. "Strategic Interaction...", op. cit.

5. In the remainder of the paper we shall neglect the idiosyncratic circumstances of those for whom suburban location represents greater, rather than lesser, accessibility. This exclusion is serious for some metropolitan areas where decentralization of business and cultural activities is extensive. In our treatment, the central city is still notably more concentrated in relevant trip destinations than the suburb, as noted above.

6. See my paper, "Strategic Interaction ..." for a more detailed exposition of this point.

7. Location is voluntary. In this model, we assume no one is either forced to locate anywhere, or legally prevented from locating anywhere.

8. Since they are capitalized in land selling prices the present owner, or a relocating owner, does not bear the burden unless the tax rate changes during his tenure. But this model is interpreted as a long run model, so such changes are assumed adjusted to through capitalization and backward shifting during land sales.

9. This, of course, results from omitting all sources of locational taste other than income level.

10. If differential public output levels are a cause as well as simply an effect of location decisions, this opens up a possibility of instability in the system as a whole; since households will be making location decisions on the basis of a present set of output differences, and these very decisions will change the output differences to provoke new rounds of unsatisfied adjustment.

11. With "pure" public goods no additional resources would be needed: the level of "consumption" of the public goods by each member of the population would depend only on the level of public goods provision (a given total resource use) and be independent of the number of people who were to share in the consumption.

12. Since we hold total SMSA population constant for convenience we speak of the location decision as an interjurisdictional shift rather than as a direct locating from outside the SMSA.

13. In a dynamic setting, they move at speeds directly related to the size of such gains. See next section.

14. The spatial characteristics of the suburb, and the rationale for this treatment of travel costs, will be made clear below in the discussion of land value determination.

15. Since we shall see that this ceiling is a policy variable whose optimal value depends on the other locational variables in the system, business location is in a deeper sense endogenous.

The author is currently developing other models in which business location <u>demand</u> is also made endogenous, parallel with residential location <u>demand</u>.

16. We are neglecting neighborhood amenities and topographical and micro-climatic differences.

17. The presence of given business activity will of course influence this.

18. A slight source of differences in real prices throughout the suburb is that successive migrants have different valuations of travel time. Transactions and moving costs also modify the statement in the text. But it affects only slightly the argument that the effective price the marginal migrant will have to pay is his valuation of travel costs from the margin plus the rural price overbid.

19. To equation 7.

20. We omit governmental and other non-profit uses for simplicity.

21. This has the effect of stipulating the maximum number of households (thus, approximately the maximum population) which can legally reside in the suburb. It is possible for the population which <u>desires</u> to move to the suburb to exceed the maximum allowable. If so, <u>the maximum</u> allowable population will be the ceiling population.

22. Alternatively, this might be specified in terms of amount of value added permitted.

23. There is also the practical problem of such taxes giving rise to unsatisfactory incentive effects — so-called dead-weight loss effects (decreased efficiency of resource allocation).

24. $$\frac{\partial r_1}{\partial T_1} = -g_1 + \frac{1}{2} Q(h) y_{j(n_1)} (1-T_1) \frac{R_1}{N_1 \bar{y}_1} \left(\frac{\partial G_1}{\partial P_1^R} \delta P^R - \delta G \right) \frac{\partial \Pi^{D-1}_{j(n_1)}}{\partial \Pi^J_{j(n_1)}} \frac{\partial g_1}{\partial \hat{n}_1},$$

with the first term negative and the second term positive.

($\delta P^R \equiv P_1^R - P_2^R$, $\delta G \equiv G_2 - G_1$; Π^{D-1} is the inverse function to Π^D.)

25. $$\frac{\partial r_2}{\partial T_2} = -g_2 + \frac{1}{2} Q(h) y_{j(n_1)} (1-T_2) \frac{R_2}{N_2 \bar{y}_2} \left(- \frac{\partial G_2}{\partial P_2^R} \delta P^R + \delta G \right) \frac{\partial \Pi^{D-1}_{j}}{\partial \Pi^J_{j(n_1)}} \frac{\partial g_2}{\partial \hat{n}_1},$$

with the first term negative and second term positive.

26. Conditions are easily conceivable which might -- which in fact may -- homogenize the density use throughout the entire metropolitan area. No specialized suburban function in terms of relative density would then remain.

27. Of course, an absence of jurisdictional advantages would prevent the same pattern of spatial distribution and cross-over use from developing, as will be seen below.

28. Z_B has much the same purpose and effect as Z_R with respect to preserving low density use. Therefore, we bunch the two together in both variants.